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ERRATA

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Page 205, Title of paper "F^2 " should be "F_2".
Page 236, Footnote reference should follow author's name
Page 240, line 14, "expreiment" should be "experiment."
Page 240, line 15, "passsed" should be "passed."
Page 243, page heading should be "Leonian: Valsa apple canker."
Page 243, line 10, omit dash after "μ".
Page 249, page heading "Wof" should be "Wolf."
Page 259, page heading "Rumboid" should be "Rumbold."
Page 265, legend of figure 3, "Waer" should be "Water.
Page 266, heading in table "Pycoida" should be "Pycnidia."
Page 266, heading in table, add "μ" to "Mean size in.".
Page 266, plate IX, figures are reversed.
Page 271, add 1 to page number.
Page 271, table title add "S" to first word.
Page 271, footnote add "k" to last line, first word.
Pages 277 and 278, figures are transposed.
Page 291, last 10 lines, should be at top of page.
Page 337, title "Folliage" should be "Foliage."

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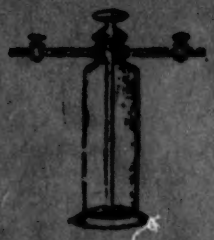

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Dr. F. Kolpin Ravn

PHYTOPATHOLOGY

VOLUME XI NUMBER 1

JANUARY, 1921

FREDERICK KOLPIN RAVN

H. H. Whetzel and H. B. Humphrey

With Portrait. Plate 1

The death of a great man at the close of a long and fruitful life touches us as does a passing cloud on a beautiful autumn day, but the sudden loss of a brilliant colleague in the prime of life comes like a bolt from the blue of the summer sky. Thus came the death of Kolpin Ravn on May 25 last, while on a visit in this country. But a few days before we had walked with him, talked with him, planned with him.

In the death of Kolpin Ravn plant pathology has suffered a great loss. Not only Denmark but America also will miss, with the passing years, his inspiring personality, his guiding vision, his productive genius. Not alone in physical stature, but also in mental ability and in personal charm he towered among his contemporaries, an inspiring teacher, a brilliant investigator, a rare leader, and a good friend.

Frederick Kolpin Ravn was born May 10, 1873, at Aalborg, Denmark, and died May 25, 1920, at East Orange, New Jersey. He received his early education at the Cathedral school in Aalborg, where he early showed natural inclinations toward a botanical career. In 1890 he went to the University of Copenhagen. Here, coming under the influence of the noted botanist Warming, he specialized in botany. His early botanical interests in the university were in ecology, especially the ecology of water plants. His first contribution to botanical science was an anatomico-ecological investigation on the floating ability of the seeds of certain hydrophytes. The thesis for his master's degree was on the organs of assimilation in the mistletoes. This interest in ecology continued throughout his life and strongly colored his later studies and investigations on the diseases of plants. This is especially noticeable in his work on the club-root of crucifers, where he pointed out for the first time the fundamental nature of the action of lime when applied to the soil for the control of this disease, showing that it was the response

of the pathogene to a basic condition of the soil rather than to some specific action of the lime as such.

Ravn became assistant to E. Rostrup in the botanical department of the Royal Agricultural College in Copenhagen in 1892. Under the influence of this great Danish phytopathologist he promptly turned his attention to the diseases of plants. His first interest in this field was with the diseases of trees but, influenced by Professor W. Johannsen, he soon turned to the diseases of agricultural crops, and particularly to their economic aspects. Thus it came that he undertook that extensive and intensive study of the Helminthosporium diseases of cereals which was to give him later an eminent position in cereal pathology. As a result of this investigation he was given his doctor's degree in 1900.

The following year he studied abroad in Germany, Austria, and Switzerland, working especially under Strasburger at Bonn. On his return from Germany he began his life work as associate with Rostrup in the phytopathological work in Denmark. The outstanding feature of his career from this time forward is the organization of the economic development of plant pathology in his native country. Carl Ferdinandsen, his successor, in his biography of Ravn[1] has most happily pictured those characters of the man which so eminently fitted him for the task.

"To solve the problems encountered here, Ravn was marvelously equipped. He possessed a clear, quick perception, permitting him to penetrate to the heart of the matter in question through all extraneous things, a sure scientific discretion mated with unusual practical ability, and enthusiasm for the subject in hand, which infected all with whom he worked, a quick well-poised manner which earned confidence and respect, and an equable, sunny disposition which carried him triumphant over all difficulties."

On the death of Professor Rostrup he was called to the chair of plant pathology in the Royal Agricultural College in Copenhagen, which position he filled until his death with a brilliancy and a record of attainments wholly worthy of the great master whom he succeeded.

The best evidence of his power as a teacher is the enthusiastic interest in plant pathology exhibited by the younger generation of students who came under his influence. It is, however, as the organizer of practical phytopathological work in Denmark that Ravn's ability is

[1] Nordisk Jordbrugsforsking. June, 1920. The writers are under deep obligations to Mrs. Ravn for the biographical data, especially for the translation of this biography of Ravn by his student and successor, Carl Ferdinandsen, which translation she personally prepared.

best exhibited. In this he has rendered signal service to his country and has set an example for emulation by pathologists in other lands. His leadership in this development is best shown in the positions of responsibility which came to him in this connection. From 1905 to 1907 he was Consulting Specialist in Plant Diseases to the Cooperative Agricultural Societies; from 1907 to 1918, Leader of the State Experimental Work in Plant Pathology and Leader of the Cooperative Agricultural Societies' Experimental Work in Plant Diseases; from 1907 to 1920, Consulting Specialist in Plant Diseases to the Department of Agriculture; from 1913 to 1920, Leader of the State Inspection Service for Contagious Plant Diseases; and from 1917 to 1920, Member of the Board of Supervisors of the State Seed-Testing Station. He was made a member of the State Board of Agriculture in 1920. It may well be said that phytopathological progress in Denmark during the past two decades is the work of his hands. Few of us who live longer than he will accomplish as much.

Although Ravn's interest in plant pathology was confined to no particular crop group, it is in the investigation of cereal diseases that he really won his place among pathologists. In his monograph on Helminthosporium[2] we find him at his best. This exceptional paper placed him at once in a position of authority on this important genus of disease-producing fungi, and made for him a permanent place among the leading plant pathologists of Europe and America. His other published works on cereal diseases are concerned almost entirely with problems of control, and in every case we find him making a direct contribution to our knowledge of crop sanitation and cereal disease prevention.

On invitation of the Office of Cereal Investigations, Bureau of Plant Industry, Ravn came to the United States in the spring of 1915 to give a series of lectures before the students and plant pathologists of several universities and colleges of agriculture. His itinerary took him into all of the important cereal crop states at a time of year when, from the standpoint of the pathologist, these crops are always most interesting. Wherever he went he made careful observations and notes on many diseases of cultivated plants and particularly those of cereals.

It was on the very eve of the development of something like a nation-wide realization of the importance of cereal pathology to human economy that Ravn paid his second visit to this country. If we needed any prompting as to the necessity for widespread crop sanitation imposed upon us by the Great War, Ravn was here to make the helpful sugges-

[2] Nogle Helminthosporium-Arter og de af dem fremkaldte Sygdomme hos Byg og Havre. *In* Bot. Tids. **23:** 101–321, 26 figs., 2 colored plates. 1900.

tion and give impetus and inspiration to American cereal pathologists everywhere. He told us of the successful campaign of barberry eradication that had been waged in Denmark since 1903, and did not hesitate to recommend a similar campaign against stem rust of wheat and other cereals in America. Ravn expressed much confidence in the success that would ultimately follow such a campaign of barberry eradication. He admitted that stem rust would, in all probability, always be with us, but that the damage resulting from this rust would be greatly reduced through the removal and destruction of the barberry.

In May, 1915, while visiting some wheat fields near Sacaton, Arizona, Ravn discovered and recognized in this country for the first time what in Europe is an all too common rust of wheat, namely, stripe or yellow rust (*Puccinia glumarum* Erikss. and Henn.). From that time on throughout the journey through the states of California, Oregon, Washington, and Idaho, we found stripe rust at many points and on a wide range of gramineous hosts. Other cereal diseases with which we had some slight acquaintance were observed by him, particularly certain of those induced by unsanitary soil conditions. His live interest in and wide knowledge of ecology as applied to plant pathology enabled him to make many useful and practical suggestions relative to the control of such obscure diseases as those which have sometimes been referred to as due to "soil sickness."

To those of us whose privilege it was to accompany Ravn across the continent and through the Pacific and inter-mountain states there came that kind of inspiration and high resolve we experience only when we make contact with big-souled, high-minded men. When in his presence we felt instinctively his sincerity, his honesty, and his delightful humanity. An eager listener and keen observer, nothing of importance could easily escape him. Because of these gifts, he had at his easy command a fund of knowledge rarely possessed by men engaged in scientific pursuits. Everything worth while was of more than ordinary interest to him and consequently it is not to be wondered that he was a man of very unusual ability and renown.

Ravn was an international figure in his profession. He traveled widely both in England and on the Continent and had three times visited America; first in 1910, again in 1915, and finally in 1920. When last we talked with him, he spoke with confidence of another visit here five years hence.

The ties which bound Ravn to America were not only those of professional friendship and personal esteem, but also those arising from marital relations; his wife is an American woman. We like to believe that America was thus to him a second home land. He always seemed

to feel at home among us. Certain it is that we always felt at home with him.

No other European pathologist is so widely known and so highly esteemed among his American colleagues as Frederick Kolpin Ravn. He has rendered us professional services of great worth. Had he, however, brought to us nothing but the inspiration of his genial personality, we should still have been his debtor.[3]

[3] For complete bibliography see: Christensen, C. Den Danske botaniske Litteratur 1880–1911. 1913; and Bibliographies in Botanisk Tidsskrift.

MEASURING CERTAIN VARIABLE FACTORS IN POTATO SEED TREATMENT EXPERIMENTS

I. E. Melhus and J. C. Gilman

With Five Figures in the Text

It is a well-known fact that the value of seed treatment is not constant. This is doubtless due to certain unknown variable factors. Unless these are measured, no set of data can be fully interpreted. The first of these variables is the presence of the living pathogenes on the tubers after they have been treated; second, the antiseptic action rather than disinfecting qualities of some of our fungicides used in surface disinfection of seed tubers, and third, the percentage of infection resulting from the presence of the pathogene in the soil. There are other factors that influence the results obtained in any set of seed treatment experiments, but the three cited above are probably the most important, and need to be measured in any well-planned series of field trials.

It has been quite generally assumed that when potatoes were treated with either formaldehyde or mercuric chloride that disinfection was quite complete. That such is not the case was clearly brought out in some of our seed treatment experiments in 1919. The seed was treated with various dilutions of formaldehyde and mercuric chloride at different temperatures and allowed to dry as in practice. Subsequently these tubers were examined in the laboratory before planting for the presence of living pathogenes i. e., *Actinomyces scabies* and *Rhizoctonia solani*.

A word of explanation of the technique utilized may serve to give a clearer understanding of the results obtained. In the case of common scab, isolations were made from the scab sori following treatment, using the method described by Shapovalov[1]. This consists of plating from the tissues just below the scab sorus. Two plates were made from each sorus and a like number from check tubers that received no treatment. These were held at favorable temperatures for the growth of the organism (22°C.) for three days and then counts were made of the number of colonies. In the case of *Rhizoctonia solani*, the sclerotia were picked off from the treated and untreated tubers and planted on potato agar plates. This organism grows rapidly at room temperature so that the

[1] Shapovalov, M. Effect of temperature on germination and growth of the common potato-scab organism. Jour. Agr. Res. **4**: 129–133. 1915.

living and dead sclerotia could usually be counted by the second or third day. The seed treatments used and the results obtained are recorded below.

THE EFFICIENCY OF SURFACE DISINFECTION ON POTATO TUBERS. ACTINOMYCES SCABIES.

The data from plates poured from scab sori which had been treated for various lengths of time, concentration of formaldehyde and temperatures are given in Table 1. Two facts are outstanding; first, that in only one of the treatments were all the organisms in the treated sori killed, and second, that in the untreated, all the sori did not contain viable organisms.

From the standpoint of toxicity of the fungicides, formaldehyde and mercuric chloride at the strengths used seem to be about equally efficient. The toxicity varied with the time of exposure, and the temperature.

The extent of disinfection is registered in terms of the number of colonies. Some idea of the thoroughness of the disinfection can be gained by comparing the figures in the columns headed, "number of colonies," under "treated" and "checks."

In the 7 modifications of the formaldehyde treatment the percent viable after treatment ranged from 3.6 to 0 per cent. These percentages will vary with any given set of isolations from treated and untreated tubers; therefore, the percentages cited above should be taken merely as indicators of the toxicity of any given treatment and not as an absolute expression of its value.

TABLE I

Toxicity of Formaldehyde and Mercuric chloride to Actinomyces scabies

TREATED							CHECKS		
Fungicide	Concentration	Temperature	Time Min.	Cover Min.	No. plates	No. colonies	No. plates	No. colonies	% viable after treat.
CH_2O	1–120	50° C.	2½	15	30	18	30	494	3.6
"	"	"	"	1 hr.	38	0	38	2851	0
"	"	5–6° C.	2 hrs.		20	6	20	1789	0.3
"	"	10° C.	"		10	2	10	414	0.5
"	"	20° C.	"		10	1	10	769	0.1
"	1–240	5–6° C.	"		20	12	20	1398	0.8
"	"	20° C.	"		28	8	28	1640	0.5
$HgCl_2$	1–1000	23–20° C.	1½ hrs.		20	9	20	3071	0.3

Mercuric chloride of the standard formula gave 0.3 per cent viable after treatment. The data show clearly the fungicidal action and efficiency of formaldehyde and mercuric chloride. It is apparent that a great number of organisms are killed but not all. Considering the great number that is present in a sorus and the number of sori on a tuber it is clear that even on treated seed many viable organisms go into the ground. If then conditions are favorable for the multiplication of the same, the progeny of treated seed has ample opportunity to become infected. In other words, since surface disinfection is not absolute, the organism is transmitted into the ground on the seed and has an opportunity to multiply and infect the progeny.

The results obtained on the viability of the pathogenes after treatment in the laboratory were compared with the amount of diseased progeny found in the field for any given treatment. The tubers, after treatment, were cut to one or two "eyes" and placed in parallel rows two hundred sets to the row. Checks were placed at approximately every sixth row. The seed potatoes were of the early Ohio variety badly infected with common scab. Thirty-six different treatments were tried. In the fall the rows were dug and the progeny divided into clean and diseased progeny and weighed. The per cent of diseased progeny was calculated and these are the figures used for comparison with the laboratory data obtained previously.

In figure 1 the results secured in the various seed treatments on *Actinomyces scabies* in the field and in the laboratory in 1919 are compared graphically. The solid histographs represent the field data: the outlined graphs the laboratory data. The field data is given in per cent scab per row. The laboratory data in per cent of plates showing colonies in the treatment.

Examination shows that in eight of the eleven cases where comparison is made that the per cent of scab in the field is less than the per cent of plates showing colonies in the laboratory. The wide variation in percentage of common scab in the different treatments was doubtless due, in the cases where this percentage is excessive, to soil infestation. The exceptions to this condition are all the hot formaldehyde treatments of above 2 minute duration. In this group the laboratory data gave a lower percentage of scab on the plate cultures and a higher percentage in the field. Nevertheless, when the treatments are considered comparatively we find that the 1–120 treatment at 50°C for 1 minute showed a greater percentage of scab present in both field and laboratory than did the same treatment for 2½ or 5 minutes. The 2½ minute treatment with an additional covering of 1 hour gave identical percentages with the 5 minute, not covered,

treatment in both field and laboratory. These graphs show that there is sufficient correlation between the laboratory and field data to give the laboratory data a distinct value in forecasting what will happen in the field.

RHIZOCTONIA SOLANI

The response obtained in planting 900 sclerotia of Rhizoctonia on potato agar is shown in Table 2. Five hundred and seventy of these were taken from potatoes treated in seven different ways. In six of the trials recorded, formaldehyde of two different concentrations was used. The time of exposure varied from 2½ minutes to 2 hours and the temperature from 6–8 to 50° C. In the seventh trial mercuric chloride was used. The average viability in the seven trials was 96 per cent. Three hundred and thirty sclerotia that received no treatment were tested as to viability before the treatments were made on a particular lot of seed potatoes. In the treated lots, from zero to 10.5 per cent of the sclerotia were viable after the treatments. This confirms the findings made on *Actinomyces scabies* in that it shows that a certain percentage of the organisms on treated tubers escape the effect of the treatment and are carried into the soil on the seed. Of course this is not a very large percentage, but with favorable conditions for their growth and subsequent development, a considerable percentage of infection may result.

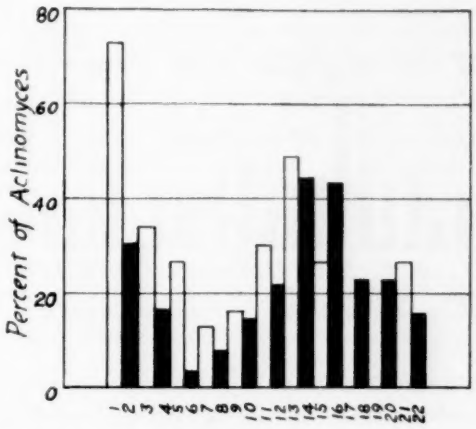

FIG. 1. COMPARISON OF FIELD AND LABORATORY DATA IN THE CONTROL OF COMMON SCAB.

1 and 2	Infected, not treated.			
3 and 4	CH_2O	1–240	6–8° C.	2 hrs.
5 and 6	CH_2O	1–120	6–8° C.	2 hrs.
7 and 8	CH_2O	1–120	20° C.	2 hrs.
9 and 10	CH_2O	1–120	48–50° C.	mom.
11 and 12	CH_2O	1–120	48–50° C.	mom. covered ½ hr.
13 and 14	CH_2O	1–120	48–50° C.	1 min.
15 and 16	CH_2O	1–120	48–50° C.	2½ min.
17 and 18	CH_2O	1–120	48–50° C.	2½ min. covered 1 hr.
19 and 20	CH_2O	1–120	48–50° C.	5 min.
21 and 22	$HgCl_2$	1–1000	20° C.	2 hrs.

TABLE 2

The toxic action of Formaldehyde and Mercuric Chloride under various conditions on the Sclerotia of Rhizoctonia

TREATMENT					TREATED SEED		CHECKS	
			TIME		SCLEROTIA		SCLEROTIA	
Fungicide	Dilution	Temperature	Dipped	Covered	Planted	Per cent Grew	Planted	Per cent Grew
CH_2O	1–120	50° C.	2½ min.	¼ hr.	50	2	30	90
"	"	"	"	1 hr.	70	8.5	50	92
"	"	6–8° C.	2 hrs.		50	4	50	100
"	"	20° C.	"		50	2	50	100
"	1–240	6–8° C.	"		50	0	50	92
"	"	26° C.	"		100	8	50	92
$HgCl_2$	1–1000	20° C.	1½ hrs.		200	10.5	50	98

In figure 2 a graphic comparison of the various seed treatments on *Rhizoctonia solani* in the laboratory and field is shown. The field data were obtained from seed of the early Ohio variety, handled as described under the common scab experiments. The solid histographs show the percentage of diseased progeny for each treatment. The outlined columns give the percent of viable sclerotia present after each treatment in the laboratory. Thirty-one cases are presented. In 16 cases the laboratory data showed a higher percentage of viable sclerotia than the percentage of infected progeny. In the other 15 cases the reverse was true. Nevertheless, the correlation between these two sets of data is very marked when the difference in method of measurement of the effectiveness of the treatment is considered. As a rule when the laboratory data showed a large percentage of viable sclerotia present after treatment, the field data gave a high percentage of infected tubers among the progeny from the seed treated in the same manner. The chief inconsistencies are found in columns 5 and 6, 7 and 8, 17 and 18, 33 and 34, 43 and 44, 47 and 48, 49 and 50, 57 and 58. In these eight cases we have brought out strikingly the difficulties of insufficient data due to too few trials. This point will be more fully discussed when we take up the question of soil infestation. Differences in soil infestation which would more than account for the slight inconsistencies found in this series manifested themselves when the same treatment was repeated several times in the field. On the whole the laboratory data was confirmed in the field and the number of viable organisms present after a treatment may be used as an indicator of the effectiveness of a treatment as a control measure.

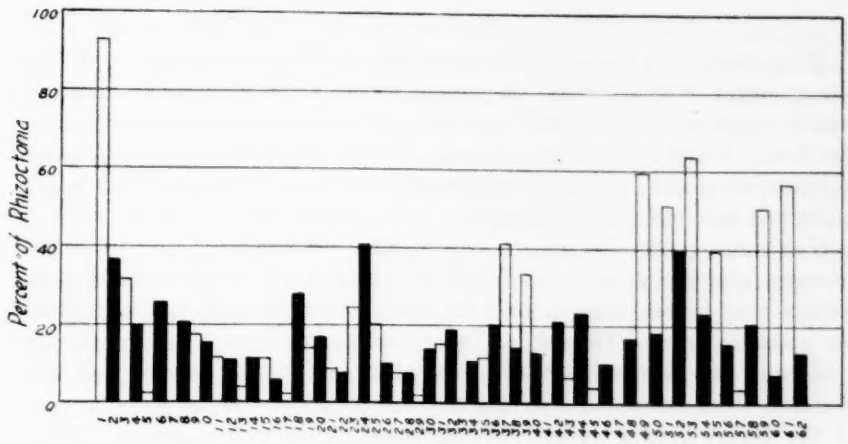

FIG. 2. COMPARISON OF FIELD AND LABORATORY DATA IN THE CONTROL OF BLACK SCURF

1 and 2	Infected, not treated.				
3 and 4	CH_2O	1–240	6–8° C.	½ hr.	
5 and 6	CH_2O	1–240	6–8° C.	½ hr.	presoaked 24 hrs.
7 and 8	CH_2O	1–240	6–8° C.	2 hrs.	
9 and 10	CH_2O	1–240	6–8° C.	2 hrs.	presoaked 24 hrs.
11 and 12	CH_2O	1–120	20° C.	½ hr.	
13 and 14	CH_2O	1–120	6–8° C.	2 hrs.	
15 and 16	CH_2O	1–120	20° C.	½ hr.	
17 and 18	CH_2O	1–120	20° C.	2 hrs.	
19 and 20	CH_2O	1–120	50° C.	1 min.	covered ½ hr.
21 and 22	CH_2O	1–120	50° C.	1 min.	covered 1 hr.
23 and 24	CH_2O	1–120	50° C.	2 min.	dried immediately.
25 and 26	CH_2O	1–120	50° C.	2 min.	covered ½ hr.
27 and 28	CH_2O	1–120	50° C.	2 min.	covered 1 hr.
29 and 30	CH_2O	1–120	50° C.	2 min.	covered 1 hr. presoaked 24 hrs.
31 and 32	CH_2O	1–120	50° C.	2 min.	covered 2 hrs.
33 and 34	CH_2O	1–120	50° C.	2 min.	covered 5 hrs.
35 and 36	CH_2O	1–120	50° C.	2 min.	covered 10 hrs.
37 and 38	CH_2O	1–120	50° C.	5 min.	dried immediately.
39 and 40	CH_2O	1–120	55° C.	1 min.	dried immediately.
41 and 42	CH_2O	1–120	55° C.	1 min.	covered 1 hr.
43 and 44	CH_2O	1–60	50° C.	2 min.	dried immediately.
45 and 46	CH_2O	1–60	50° C.	2 min.	covered 1 hr.
47 and 48	CH_2O	1–60	50° C.	2 min.	covered 5 hrs.
49 and 50	$HgCl_2$	1–1000	6–8° C.	½ hr.	
51 and 52	$HgCl_2$	1–1000	6–8° C.	½ hr.	presoaked 24 hrs.
53 and 54	$HgCl_2$	1–1000	6–8° C.	1 hr.	
55 and 56	$HgCl_2$	1–1000	6–8° C.	1½ hrs.	
57 and 58	$HgCl_2$	1–1000	6–8° C.	1½ hrs.	presoaked 24 hrs.
59 and 60	$HgCl_2$	1–1000	6–8° C.	2 hrs.	
61 and 62	$CuSO_4$	1–300	6–8° C.	2 hrs.	

ANTISEPTIC ACTION OF MERCURIC CHLORIDE

While making a comparative study of the effect of disinfectants on the sclerotia of Rhizoctonia on potato tubers some data were obtained which throw additional light on the confusion which now shades this problem. During the course of these studies it was found that mercuric chloride when used for short periods of time, acts to some extent as an antiseptic and not a disinfectant.

If in plating sclerotia from tubers treated with mercuric chloride the sclerotia after being removed from the potato with a sterile knife were turned over before being placed on the medium, a large percentage of the sclerotia grew. The surface of the sclerotium that was next to the epidermis was exposed to the air in the dish. This growth was not like that from untreated sclerotia but was a tuft of hyphae growing out of the center of the sclerotium and standing up perpendicular to the surface. (Fig. 3.) Microscopic examination showed it to be Rhizoctonia.

Table 3 shows the results of plantings made from sclerotia treated with mercuric chloride. It shows that many sclerotia are not killed in exposures less than two hours. It should be noted that Gloyer[2] found that mercuric chloride 1-1000 killed all of the sclerotia. This may have been due to the limited number of trials or some other combination of conditions not obvious from his data.

From these data it will be noted that the accepted time of exposure (90 minutes) does not kill all the sclerotia but that about 10 per cent of those plated grew. The gradual increase in toxicity with the increased time of exposure shows how slowly mercuric chloride penetrates. With a large sclerotium this factor becomes an important one.

The most plausible explanation of this phenomenon seems to be; that even after three washings in sterile water, sufficient mercuric chloride is left on the surface of sclerotia to inhibit the growth of the fungus. This substance did not penetrate the sclerotium, however, but was confined to the surface that was wetted at the time of the treatment. When the sclerotium was plated in the same relative position as it held on the tuber the fungicide remaining on the surface of the sclerotium inhibited its growth, but when it was turned over, the part of the sclerotium to which the fungicide had not penetrated was exposed to the moist atmosphere within the dish and growth readily took place. Additional evidence of the diffusion of the fungicide around the sclerotium

[2] Gloyer, W. O. The efficiency of formaldehyde in the treatment of seed potatoes for Rhizoctonia. N. Y. (Geneva) Agr. Exp. Sta. Bul. 370, pp. 417–431. 1913.

from tubers that had been treated with mercuric chloride was shown by behavior of contaminating organisms in the plates. These organisms (Penicillum, Rhizopus and Aspergillus spp. chiefly) would always leave a sterile zone immediately surrounding such sclerotia while on the check plates where sclerotia from untreated tubers were placed no such zone was observed. Sclerotia killed with formaldehyde solution did not show a sterile zone around them when plated. Further when 100 cc. of water used for the third washing was evaporated to 10 cc. a precipitate of mercury was obtained with stannous chloride as a reagent, Some of the water used in the third washing is transferred to the media with the sclerotium which would seem to account for the presence of mercuric chloride around each sclerotium on the plate.

FIG. 3. RHIZOCTONIA SCLEROTIUM FROM POTATO TUBERS TREATED WITH CORROSIVE SUBLIMATE 1–1000 FOR 1½ HOURS SHOWING GROWTH FROM ITS CENTER.

MEASURING SOIL INFESTATION

Where the soil is infested with *Actinomyces scabies* and *Rhizoctonia solani* the value of a particular treatment is not clearly defined. Furthermore the infestation is never constant and the activity of these pathogenes is influenced by climatic factors which vary with the season. However, this variable must be measured in order to interpret a particular set of seed treatments. This has not been done in any set of potato seed treatments that have come to the authors' attention. The fact makes it seem justifiable to record the following results obtained in 1919 at Ames, Iowa, in studying the toxic action of various fungicides. Seed potatoes of the early Ohio variety badly infected with common scab and black scurf were used together with apparently clean seed from the

TABLE 3

The Action of Mercuric Chloride on the Sclerotia of Rhizoctonia

TREATMENT		TREATED SEED		CHECKS	
		SCLEROTIA		SCLEROTIA	
Dilution	Time of exposure	Planted	Percent Grew	Planted	Percent Grew
1–500	90 min.	100	18	50	94
1–1000	30 "	140	51	90	95
"	60 "	90	43.3	90	95
"	90 "	530	10.9	90	95.5
"	120 "	50	0	50	100
1–2000	90 "	150	26.6	50	100
"	120 "	50	5.8	50	100

same source. The seed was cut to one or two "eyes" and planted 200 sets per row. The rows served as checks in a series of 36 different treatments and were distributed every sixth row. In the fall when the crop was harvested the percentage of common scab and black scurf was recorded by weight. Figure 4 shows 18 checks in three series, A. B. and C., where the Rhizoctonia infection was measured.

In the A series apparently clean seed was treated with mercuric chloride (1–1000) for 1½ hours. The apparently clean seed was obtained by selecting tubers from the bin on which no sclerotia were seen. It is not improbable however, that some few were overlooked due to irregularities of the surface and presence of inorganic matter. The clean seed was also used in B, but it received no treatment; in C untreated infected seed was used. The outlined histographs represent the percentage of black scurf by weight on the progeny in the fall. The shaded column is the mean of the six different checks. In the A series where apparently clean seed was used the amount of scurf varied from one to 18 percent with a mean of 6 per cent. This amount of infection was doubtless due to the scurf organisms present in the soil. The variation in soil infestation in the plot is shown in the variation in percentage of infected progeny. In the B series, the apparently clean untreated seed, we have a mean of 13 per cent which is the combined effect of the organisms carried on the seed and those already in the soil. It would seem that apparently clean seed is not free from scurf organisms and that seed treatment reduced the per cent of black scurf on apparently clean seed about 7 per cent. This is crediting 6 per cent of

the infection present on the progeny to organisms present in the soil as indicated in the A series.

In the C series which shows infected seed not treated we have a mean of 37 per cent infection in the six checks. This again is the combined infection resulting from the scurf organisms carried on the seed and those present in the soil.

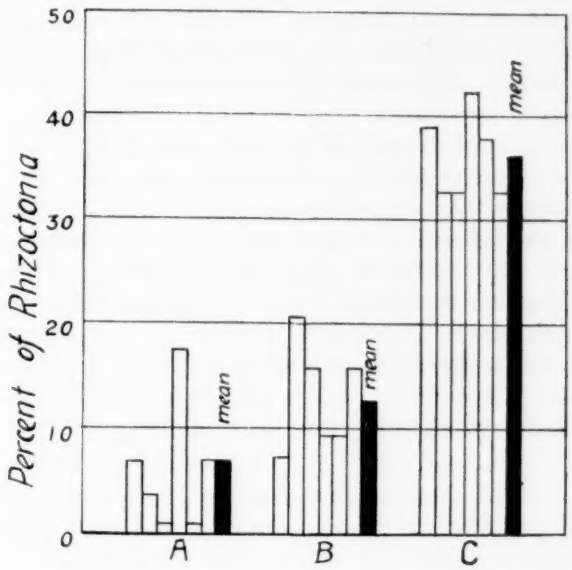

FIG. 4. MEASURING VARIATION IN SOIL INFESTATION BY RHIZOCTONIA SOLANI
A. Clean treated ($HgCl_2$ 1–1000 6–8° C. 1½ hrs.)
B. Clean seed not treated
C. Infected seed not treated

In figure 5 a similar series of checks used in the experiments on common scab are shown. In series A, the clean seed treated with mercuric chloride 1–1000 for 1½ hours showed a mean of 18 percent with a distribution of 10 to 29 per cent. Series B, consisting of clean seed not treated, showed a mean of 24 per cent with a distribution of 14 to 35 per cent infected progeny. In series C, the infected not treated group, the mean was 31 per cent with a distribution of 12 to 49 per cent. In addition to the same facts that have been pointed out for the black scurf series; that is, that the 18 per cent in series A shows the amount of soil infection; the difference between this figure and the 24 per cent in series B, 6 per cent, shows the amount of infection carried on the apparently clean seed, and the 31 per cent in series C shows the total

amount of infection present in the soil and that carried on infected seed; it should be noted that in certain instances, as for example, with the two rows in series A which show 23 and 29 per cent diseased progeny respectively two check rows are entirely inadequate as a measure of soil infestation. It is only by repeating the check rows at sufficiently close intervals that a true picture of the soil conditions can be attained. Variations which occur in all the series show that there are present in the soil, conditions which favor the development of the parasite in one case or inhibit it in another and in the same field. Such variations necessitate the use of frequent and varied checks in order that they may be correctly measured.

From this data where the check rows were repeated six times, the necessity of a large number of checks becomes obvious. Just how many should accompany any set of conditions is not so certain. It is well known that the reliability of any set of data is proportional to the square root of the number of repetitions. However, in the matter of checks the large number necessary for mathematical certainty cannot be used; therefore the question of how many to use remains. From the data given it is obvious upon inspection that one set of checks would

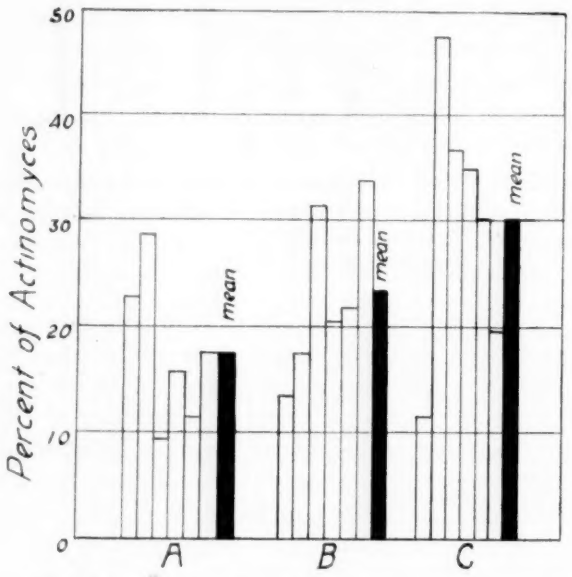

FIG. 5. MEASURING VARIATION IN SOIL INFESTATION BY ACTINOMYCES SCABIES
A. Clean seed treated ($HgCl_2$ 1–1000 6–8° C. 1½ hrs.)
B. Clean seed not treated
C. Infected seed not treated

be inadequate. For example in the common scab series the first two clean treated check rows gave a higher percentage of scabby progeny than four of the clean not treated and than two of the infected not treated seed. Again two of the clean not treated seed gave as much or more diseased progeny than did three of the infected not treated seed. Hence it may safely be concluded that in this case at least two checks are inadequate. Three sets of checks are little better, for with the combination of the three best infected not treated with the worst clean treated we find that the clean treated average 23.3 per cent of their progeny diseased while the infected not treated had but 21.3 per cent diseased. Such a case is not probable but is possible. A similar case is found in the Rhizoctonia series if the three best clean not treated be compared with the three worst clean treated, where the averages would be 8.3 and 11.3 per cent diseased respectively. Again with four repetitions of the checks the chances of wrong interpretation are lessened but are not entirely obviated. Where the presence of the organism often cannot be recognized as in the case of scab, the necessity of an increased number of checks over the case where the presence of the organism is easily observed, shows in these figures. This fact is brought out by comparison of figures 4 and 5. The greater differences between the means of the groups in figure 4 show that the dividing line of the tubers into clean and infected seed was much more efficient than in the scab series where the differences are less.

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FURTHER STUDIES ON BACTERIAL BLIGHT OF SOYBEAN

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With One Figure in the Text

It will be recalled that two papers on bacterial blight have appeared during the past year, one from investigations conducted in Wisconsin by Miss Coerper (1) and the other in North Carolina by the junior writer (5). The disease in the case of the former of these accounts, is ascribed to a hitherto undescribed organism, *Bacterium glycineum*, and in the latter to an organism to which the name *Bacterium sojae* has been applied. Furthermore, the paper by Miss Coerper appeared in published form while the junior writer's manuscript was in press so that opportunity was not afforded for a critical comparative study of the two diseases and of the causal organisms. The foot-note (l. c. p. 120) accompanying this account was prepared by comparison with the published descriptive report, as has been indicated. Through the courtesy and kindness of Miss Coerper and of Dr. L. R. Jones, specimens and cultures have subsequently been received and it is, therefore, the present purpose to record the results of these comparative studies in order to clarify the problem of the identity of these soybean bacterial blight diseases.

DIFFERENCE IN APPEARANCE OF THE DISEASES

Comparison of type specimens of diseased leaves shows that no differences are present which are sufficiently distinctive to make it possible to separate the two in the field. As previously indicated, however, minor differences, as in the color of the diseased areas and of the dried bacterial exudate, are apparent which no doubt vary dependent upon weather conditions and the stage of development of the disease.

Even though the disease in North Carolina has been quite prevalent during the present season, it appears to be confined to the leaves and has not been observed also on stems and pods as is the case in Wisconsin. It is doubtful if any means of identification save isolation of the causal organism can be relied upon. Isolations made during the present season from leaves collected in the vicinity of Raleigh, Oxford and Edenton, N. C., agree with those of previous seasons. Opportunity has not been afforded, therefore, to observe under field conditions, the

two leafspot diseases, which as indicated by the cultural studies to follow, must occur in Wisconsin.

ORIGIN OF CULTURES

Five strains of soybean blight, four from Wisconsin and one from North Carolina, have been employed in the cultural studies. Data on those from Wisconsin can best be presented by quoting rather fully Miss Coerper's notes of explanation which accompanied the cultures.

No. 268. Isolated August 29, 1917. Naturally infected leaves were placed in damp chamber over night. Drops of bacterial exudate developed and streaks on potato agar slants were made by direct transfer. One of these isolations proved pathogenic when atomized on soy-bean leaves. Pathogenicity proved a number of times. Type strain. Browns peptone media. Employed in all cultural and inoculation work in soybean blight studies.

No. 269. Isolated August 31, 1918. Young leaf lesions were placed in 95 percent alcohol for an instant, then for one minute in 1–1000 solution of bichlorid of mercury and washed through six sterile water blanks. Dilution plates on potato agar were made from macerated lesions. Pathogenicity proved from inoculations in the field in 1918 and in the greenhouse during the winter of 1918–1919. Browns peptone media.

No. 270. Isolated January 17, 1919, from naturally infected leaf collected in the greenhouse. Surface sterilization was effected as in the case of No. 269 and dilution plates made. Does not brown peptone media. Pathogenicity proven by inoculation of plants in the greenhouse.

No. 211. This is the first strain isolated in the study of the disease, and was the strain used in all cultural and much of the inoculation work in comparison with the type strain No. 268. Isolated September 25, 1915. Does not brown peptone media.

The strain from North Carolina, herein designated No. 19, was isolated June 12, 1919, agrees culturally with a strain isolated during July of the previous year, has several times been proven to be pathogenic and is the type strain of *Bacterium sojae*.

CULTURAL STUDIES

Method: Since it was early found to be impossible to verify the reaction of the strains toward carbohydrates by use of media prepared according to methods which have previously been employed, other methods, which included a more accurate adjustment of initial reaction and a more careful preparation of sugars, were adopted. These methods take advantage of recent refinements in methods of adjusting the reaction of culture media colorimetrically and electrometrically to supplant the inaccurate and illogical titration method which employed phenolphthalein as an indicator. They also take into account the well known fact that not only acid or alkali but also heat, can hydrolyze sugars and therefore interfere with the proper preparation of sugar media.

As is indicated in the preparation of Krumweide's brilliant green agar, sugars in distilled water and therefore apart from the influence of a complex solvent like culture media with its acid or alkali content, can be sterilized without appreciable hydrolysis and the sterile sugar can then be added to sterile media using aseptic precautions to prevent the necessity of subsequent sterilization. Accordingly, stock 20 per cent sugar solutions in distilled water were sterilized in the autoclave at 10 pounds for 10 minutes. Stock nutrient agar and bouillon were made as usual, were adjusted to the desired hydrogen ion concentration by comparison with the buffer color standards, were flasked and sterilized in 95 cc. quantities and then set aside until cool. When 5 cc. of the sugar solution was added to such quantities of media, using aseptic precautions, it contained 1 per cent of the sugar to be investigated. In the case of agar, which had an initial hydrogen ion concentration of pH = 7.0–7.2, the sugar was added to cooled but not yet solid media. It was then poured before the agar had set, into sterile test tubes, and was incubated for 48 hours to determine its freedom from contamination.

In making solid indicator media, sterile litmus solutions were prepared and the litmus was added in the same manner as the sugars. After growth had proceeded for a given time, in bouillon cultures containing sugars, which were used to check the results with solid indicator media, tests for acid were made by adding brom cresol purple or phenol red to the cultures and comparing them directly with the standards and with the uninoculated tubes. This last precaution seems to be of significance in the light of findings by Grace and Highberger (3) on variation in uninoculated media.

Litmus agar. Litmus agar in triplicate sets for each strain and for each of the sugars was used as indicator media. Each series included dextrose, saccharose, lactose, maltose and glycerine. Furthermore, each series was inoculated from the same stock culture and all cultures were incubated at 28 degrees C with the resultant reaction indicated by the litmus. No differences in strains were apparent on dextrose since the blue had practically disappeared from all tubes by the seventh day and they were reddened throughout. A slight reddening began on all strains on saccharose after three days and the upper part of the stab was definitely reddened by the seventh day. On each of lactose, maltose, and glycerine, Nos. 268 and 269 were able to bring about a slight change which was first apparent after about a week and the upper portions of the tubes became with age, a reddish brown, whereas, Nos. 211, 270 and 19 produced no acid from these sugars.

Sugar broths. In order to check the changes in reaction in solid media, the several carbon compounds were employed in 2 per cent peptone solutions. The media which had been adjusted to pH = 7.2 were inoculated and the changes after seven days were determined by comparison with buffer color standards. These data in terms of pH concentration are presented in the following tabulation:

Reaction to sugars in peptone broth by soybean blight organisms

STRAIN	DEXTROSE	SACCHAROSE	MALTOSE	LACTOSE	GLYCERINE
268	5.4	6.2	6.7	6.5	6.2
269	5.4	6.4	6.4	6.4	6.4
19	6.6	7.0	7.4	7.5	7.6
211	6.4	6.6	7.6	7.4	7.6
270	6.3	6.4	7.6	7.6	7.6

It will be noted that the results are in general accord with those on indicator media in that Nos. 268 and 269 are able to form acid from each of the sugars whereas Nos. 211, 270 and 19 form acid from dextrose and saccharose alone.

Fermentation tubes: Sterile fermentation tubes were filled under aseptic conditions with sugar broths. The dissolved oxygen gas was not driven off but it is not apparent that such a procedure is of value since it remains to be proven that heated broths do not again take up oxygen on cooling. The several strains have given similar results with heated and unheated tubed broths. No turbidity developed in the closed arm in seven-day old cultures thus indicating that the organisms are strictly aerobic. Other organisms may of course, react differently but the dispelling of dissolved oxygen is apparently a factor of less importance than the agitation given fermentation tubes in handling them during examination. Slight agitation may cause apparent growth in the closed arm in the case of all strains so that it becomes easily possible to misinterpret the oxygen relation through the use of fermentation tubes.

Character of colonies: It was only by increasing the percentage of agar above that which the writer was accustomed to use that it was possible to duplicate the appearance of colonies with respect to margin, contour and surface markings shown in Plate XV of Miss Coerper's paper. While it has long been known that the density and viscosity of media exert a profound influence on the character of the colonies (2), the importance of these factors has been largely overlooked in studies

involving the cultural characters of bacteria. In the case of the soybean organisms, the differences in the character of the margins in 1, 2, and 3 per cent nutrient agars which were alike in all other respects are shown in figure 1. It will be seen that the margin of the colony becomes more uneven as the density and viscosity increases. Size, elevation and surface markings are also profoundly modified.

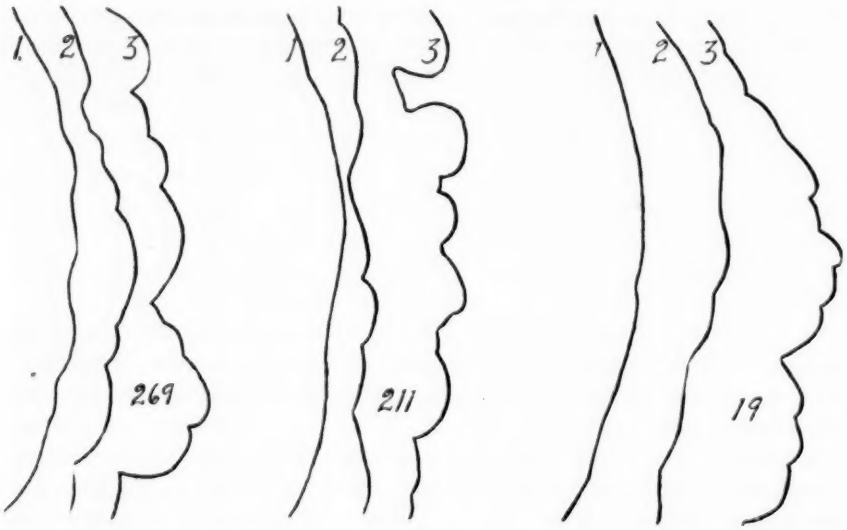

FIG. 1. VARIATION IN THE MARGIN OF COLONIES OF NOS. 269, 211 AND 19 WHEN GROWN ON 1, 2, AND 3 PER CENT NUTRIENT AGAR, AS SEEN UNDER THE HIGH POWER.

DISCUSSION

By avoiding the heating of media after the addition of the sugar, one prevents the reaction between the amino groups and the sugar with the resultant production of acidity as occurs during sterilization. Since these strains form acid weakly, their reactions are not evident with media whose initial reaction, as determined by titration with phenolphthalein, is approximately pH = 8.5. When, however, the initial reaction closely approximates absolute neutrality, as determined colorimetrically, small increases in acidity consequent on growth are detectable. This is shown particularly in the case of No. 19, which with litmus agar adjusted to pH = 8.0–8.5 gives no evidence of its ability to form acid with saccharose. A similar condition has been reported by Jones (4) for a strain of Pneumococcus which when inoculated into a medium whose initial reaction was pH 7.0 grew poorly and developed a final concentration of only pH 6.2 whereas in a medium whose initial

reaction was pH 7.6 growth was abundant and a concentration of pH 5.4 was developed.

It has been possible to verify previously published accounts of the morphology and cultural characters of the soybean bacterial blight organisms in all respects except in the reaction toward the several sugars. Nos. 268 and 269, which in Miss Coerper's discussion on variations of strains (1 l. c. p. 189) are called Strain A, are regarded as identical and are the type of *Bacterium glycineum*. They have the same reaction toward dextrose, saccharose, lactose, maltose and glycerine, from the first two of which they form acid rather strongly, but from the others, in small amounts and slowly. They furthermore, consistently cause a browning of the media. Nos. 211 and 270 which are called Strain E are like No. 19, the type of *B. sojae*. They are able to form acid from dextrose and saccharose alone and agree in being non-pigment forming.

SUMMARY

A comparison has been made of bacterial blight of soybean as described from Wisconsin and from North Carolina. The diseases differ somewhat in appearance but these differences are of minor importance and it is doubtful if one could differentiate them with certainty in the field. By the use of certain easily operable refinements which consist essentially in adjustment of initial reaction to neutrality and in reducing the hydrolyzation of sugars to negligible quantities, it is determined that the several strains of bacteria pathogenic to soybeans represent two distinct species, *Bacterium glycineum* and *B. sojae*. They differ principally in that the former produces brown pigment with certain media and forms acid from dextrose, saccharose, lactose, maltose and glycerine, whereas the latter is non-pigment forming and forms acid from the first two of these sugars only. Both organisms have been isolated in Wisconsin and proven to be pathogenic and *B. sojae* alone has been found to be associated with soybean blight in North Carolina.

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N. C. AGRICULTURAL EXPERIMENT STATION

STOCKTON MOSBY McMURRAN

JOHN W. ROBERTS

WITH ONE FIGURE (PORTRAIT) IN THE TEXT

Stockton Mosby McMurran, Pathologist in Charge of Investigations in Nut Diseases, U. S. Department of Agriculture, was born at St. Paul, Minnesota, March 8, 1887, and died at Thomasville, Georgia, September 5, 1920. He was graduated from the Virginia Polytechnic Institute in

S. M. McMURRAN

1909 and received the degree of A. M. from Washington University in 1911.

McMurran had been a member of the Office of Fruit Disease Investigations, Bureau of Plant Industry, for eight years. Previous to that time he had been connected with the Department of Plant Pathology

in the Virginia Agricultural Experiment Station, New York (Geneva) Experiment Station, and Washington University (St. Louis Botanical Garden).

His first important piece of work was an investigation of the Anthracnose of the Mango in Florida, the results of which were published in bulletin form. He was then placed in charge of Nut Disease Investigations, a position which he held until his death. Some of his investigations of pecan rosette have been published under the title "Pecan Rosette in Relation to Soil Deficiencies," and constitute a noteworthy contribution to the subject. "Wood Rot of Pecans" and "Walnut Blight in the Eastern United States" are publications resulting from investigations urged upon him by nut-growers.

McMurran was possessed of a keen sense of humor and a certain buoyancy of spirit, which made him a delightful and much sought after companion. He was also possessed of a quick, active mind, whose brilliancy quickly impressed itself upon all with whom he came in contact. At the time of his death, McMurran was just beginning to solve many of the more vexing problems in Pecan diseases and his death is a distinct loss both to nut growers and to the science of Plant Pathology.

FRUIT DISEASE INVESTIGATIONS
BUREAU OF PLANT INDUSTRY

PHYTOPATHOLOGICAL NOTES

Witches'-brooms of Pinus maritima. Witches'-brooms are often produced from a local hypertrophy of lateral shoots on *Pinus maritima* in southwestern France. Sections from a hypertrophied main shoot or from the smaller branches in the brooms show that the cambial cells are generally infected by bacteria imbedded in brown zoogloeae, which extend from one cell to the next through the bordered pits. The bacteria are best demonstrated in sections cleared in chloral phenol. They stain black with iron haematoxylin and blue with the polychrome-blue-tannin-orange method.

The nucleus and cytoplasm of the infected host cells may disappear. Occasionally the cell wall may break open, perhaps through the decomposition of the pectic substances, and the zoogloeae then push through the opening. The reactions of the host tissues are quite different from those in bacterial cankers. No giant cells, which are conspicuous in cankers, are observed in the witches'-brooms.[1]

The infection results chiefly in the differentiation of a number of cambial areas into shoot initials. As a result, an excessive number of lateral buds are formed, and these develop into shoots. In addition, the buds terminating the needle-bearing shoots, which are normally abortive, develop into branches.

Inoculations from diseased cambium to nutrient agar result in the formation of colonies of motile bacteria which appear macroscopically as brown spots in cultures three days old. The bacteria from the cultures measure 0.75μ × 3–5μ. They stain readily by the Ziehl-Nielsen process.

Bacteria from cultures ten days old were inoculated into buds of *Pinus maritima.* These inoculations resulted in the death of the buds, the tissues swarming with bacteria, but no witches'-brooms were formed. The infection experiments appear to prove the parasitism of the organism, but still leave it uncertain whether they cause the broom formation.

JEAN DUFRENOY

SERVICE DU EPIPHYTES
FRANCE.

[1] Dufrenoy, Jean. Pine-needles, their significance and history. Bot. Gaz., v. 66, p. 439–454, Nov. 1918.

The relation of mosaic disease to pickling of cucumbers. Snow's Perfection cucumbers were grown during the summer of 1920 at Arlington Farm, Virginia, for pickling purposes. The cucumber fruits showed the mosaic disease late in the season by pale blotches and rough warty areas. Incipient cases of earlier origin were doubtless overlooked. Fresh cucumbers affected by mosaic disease had a bitter taste and the texture was tough. When cucumbers are subjected to the pickling process, certain physical changes are observed. A fresh cucumber shows tissues with extensive intercellular spaces filled with air. A section of cucumber submerged in brine appears white on account of these spaces. During the pickling process this air is gradually eliminated, so that, when the fermentation is complete, the white spaces have disappeared with replacement of the air by acid brine. When the dill pickles made in the summer of 1920 were sufficiently cured, they were examined.[1] Jars 2–23, which were put up from cucumbers gathered before mosaic disease was apparent in the plot, showed practically no troubles except such as could be explained by other agencies than mosaic disease. There was, however, at least one pickle affected with mosaic disease, this being in the last jar, No. 23.[2] Beginning with the jar 24, the cucumbers were not sorted as carefully as in previous work and mosaic disease was marked. On examination of the subsequent eight jars of dill method pickles, the extreme effects of pickling mosaic cucumbers were noticed. Some cucumbers with mosaic infection have white areas with a tough, woody texture, which do not clear up during the pickling process. Other affected cucumbers become spongy or soft or slushy pickles. The pickle may be spongy only in the center, or the entire structure within the epidermis apparently may be broken down into its integral cellular parts. None of these bad pickles present disagreeable odors or putrefaction.

These preliminary results demonstrate the necessity of careful comparison of pickles made from cucumbers apparently free from mosaic, but from stock known to be affected, with pickles from stock known to be unaffected. In this way it will be possible to determine what relation may exist between this disease in the field and losses in the pickle vat, even when the stock has been sorted carefully while fresh. The

[1] These experiments were conducted in consultation with Dr. Charles Thom, of the Bureau of Chemistry.

[2] Identification of mosaic disease by Mr. W. W. Gilbert, of Bureau of Plant Industry; pickling would undoubtedly disguise many cases of incipient mosaic.

work presented indicates that cucumbers visibly affected with mosaic will not cure properly in the pickling vat.

MARGARET B. CHURCH

BUREAU OF CHEMISTRY
U. S. DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.

Foot rot of tomato. Pethybridge and Lafferty (Sci. Proc. Roy. Dublin Soc. **15**: 487–505. 1919) have applied the name foot rot to a disease of tomatoes caused by *Phytophthora cryptogea*. In view of this usage, Rosenbaum's proposal (Phytopathology **10**: 415–422. 1920) to apply the same name to a tomato disease caused by *Macrosporium solani* seems unfortunate if not untenable. Use of the generic names of the causal organisms as descriptive adjectives would still allow the use of a descriptive common name and such usage has certain additional advantages. If this suggestion is followed the two diseases of tomato would bear the common name Phytophthora foot root and Macrosporium foot rot.—*D. Reddick.*

New abstract journal. Zentralblatt für die gesamte Landwirtschaft mit Einschluss der Forst- und Teichwirtschaft, der Tier-Pathologie und Medizin is a new abstract journal issued by Prof. Dr. Richard von der Heide, of the Agricultural College in Berlin, and Robert Lewin, Berlin No 43, Prenzlauer Berg 8. It is published by Gebrüder Borntraeger, Berlin W 35, at the subscription price of 75 marks for a volume of about 500 pages. In the list of abstractors appear the names of the following pathologists: Lindfors (Experimentalfältet), Losch (Hohenheim), Molz (Halle a. S.), Schoevers (Wageningen), Zimmermann (Rostock). In the four numbers that have been seen, several central European journals are reviewed the names of which will prove decidedly unfamiliar to most American workers. Some of these journals really are new, the first volume having appeared within recent years; others bear high volume numbers but the names do not seem to have appeared frequently, if at all, in abstracting or reviewing journals. How many of these represent merely changes in spelling made possible by recent political changes has not been determined.—*D. Reddick.*

Compilation of list of new fungi. The British Mycological Society intends to publish the original diagnoses of the genera of fungi which have appeared since the last volume (XXII) of Saccardo's Sylloge, and to keep the list up to date by annual installments. Dr. J. Ramsbottom, general secretary of the Society, British Museum (Natural History), Cromwell Road, London, S. W. 7, has undertaken to compile this list,

and would welcome separates in which new genera have been described, or assistance in any way. It is believed that the list will be valuable to all interested in mycological studies.—*W. A. Orton.*

Personals. Mr. M. A. Carleton, formerly in charge of the Office of Cereal Investigations, United States Department of Agriculture, and recently plant pathologist for the United States Grain Corporation, is now employed as plant pathologist for the United Fruit Company, with headquarters at Bocas del Toro, Panama.

Dr. O. F. Burger, formerly pathologist at the California Agricultural Experiment Station, Riverside, and recently engaged in the investigation of fruit and truck crop diseases in the U. S. Bureau of Plant Industry, has become head pathologist at the Florida Agricultural Experiment Station, Gainesville. He will give special attention to the study of transportation diseases of truck and citrus crops.

Mr. R. W. Goss, formerly assistant pathologist in cereal disease investigations, Bureau of Plant Industry, with headquarters at Madison, Wis., has become assistant plant pathologist at the Nebraska Agricultural Experiment Station, where he will take up the study of the potato Fusarium problems of that region.

Dr. R. A. Jehle, formerly extension plant pathologist for the North Carolina State College of Agriculture, has accepted a similar position with the College of Agriculture of the University of Maryland, succeeding Prof. C. E. Temple, who has become professor of plant pathology in the University of Maryland.

Mr. E. J. Wortley, formerly Director of Agriculture for Bermuda, has accepted a similar position for the Nyasaland Protectorate and is located at Zomba.

ABSTRACTS OF PAPERS PRESENTED AT THE TWELFTH ANNUAL MEETING OF THE AMERICAN PHYTOPATHOLOGICAL SOCIETY, CHICAGO, DECEMBER 28 TO 31, 1920.

Experiments with Stewart's disease on dent, flint and sweet corn. CHAS. H. REDDY.

In connection with investigations on the bacterial diseases of corn carried on by the Office of Cereal Investigations, United States Department of Agriculture, two series of experiments consisting of two hundred plants each were conducted under greenhouse conditions at Madison, Wisconsin, during the winter of 1919–20, to test the relative susceptibility of one variety each of dent, flint and sweet corn to bacteria of the *Aplanobacter stewarti* type isolated from natural infections of dent, flint and sweet corn occurring in 1919 in the vicinity of Bloomington, Illinois. The same soil was used in both experiments. Thus the second experiment also served as a test on natural soil infection under greenhouse conditions where corn is grown in the soil immediately upon the removal of a diseased crop. Cross inoculations on the three kinds of corn were made with water suspensions of cultures from dent, flint, and sweet corn respectively, by hypodermic injections near the bases of corn plants. Ninety per cent of the plants inoculated were infected as determined macroscopically, and by isolations from points several inches above places of inoculation. Results indicate that the organism isolated from each, dent, flint and sweet corn is about equally pathogenic on all of the hosts under experimentation. Neither dent, flint, nor sweet corn showed marked resistance. However, on basis of intensity of infection, flint corn seemed to be the most susceptible and dent the least susceptible. There was not a single case of natural infection resulting from growing corn in soil which, immediately preceding, had produced a crop artificially infected.

Studies on corn rust. G. F. WEBER.

In connection with studies on the urediniospores of *Puccinia sorghi* Schw. carried on at the University of Wisconsin, 1919–20, data were accumulated particularly on: (1) overwintering, (2) relation of temperature to germination, (3) mode of host penetration, and (4) relative susceptibility of corn species and varieties.

Beginning October 1, urediniospores were collected every two weeks from infected corn leaves placed at different stations out of doors, and their viability tested. Through October one hundred per cent germination was obtained. Through November the germination percentage diminished gradually, and at the end of December germination ceased entirely. Studies on urediniospore germination conducted in incubators at different temperatures indicated 4°, 17°, and 32° C. to be the minimum, optimum and maximum temperatures respectively. Sectioned material fixed at twenty-four-hour intervals after inoculation indicated that germ-tube penetration of host occurred through stomata only, either with or without appressoria. Greenhouse cross inoculations on seven species of corn with spores from each species used separately indicated no specialization, each species being similarly attacked by spores from any source.

The seven species of corn varied somewhat in susceptibility progressively in the following order:

(1) *Zea everta* (pop)
(2) *Z. tunicata* (pod)
(3) *Z. ramosa*
(4) *Z. dentata* (dent)
(5) *Z. amylacea* (flour)
(6) *Z. indurata* (flint)
(7) *Z. saccharata* (sweet)

Six varieties of dent corn tested showed but slight variations as to susceptibility.

Ecologic and physiologic notes on corn smut, Ustilago zeae. L. E. MELCHERS.

It has been found that cultures of *Ustilago zeae* seem to differ in their power to produce infection. Occasionally a culture will be isolated that proves to be "very infectious," when used for artificial inoculation. Frequently cultures are isolated that cause a rather small percentage of infected plants when used in inoculation experiments. Also, it is being found that selections and crosses of corn showing resistance to smut in one locality or state are much more susceptible in other sections. There seems to be an indication that the nature of the corn plant, and the change of environmental conditions with its effect on the host, are not solely responsible for such striking differences in smut resistance or susceptibility. Work under way indicates that there are physiologic differences in the corn-smut organism, that may be of considerable importance in breeding corn for resistance to it. (Coöperative investigation by the Kansas Agricultural Experiment Station and the U. S. Office of Cereal Investigations.)

Significant points in the life history of the Philippine maize mildew. W. H. WESTON, JR.

Several Sclerosporas of corn, although not yet introduced into our own country, are spreading so widely and proving so disastrously destructive in the Orient that they now constitute a serious menace to our own crop. A study of the one which occurs in the Philippines has brought out several points, which are of interest to American phytopathologists. The conidia of this Sclerospora are produced only at night when the infected leaves are covered with a layer of dew or other moisture. Production of conidia in vast numbers from infected but still vigorous plants may continue night after night for over two months. Consequently, one diseased plant may infect the whole countryside. Conidia may be produced on corn, teosinte, sorghum, sugar cane, *Saccharum spontaneum*, and *Miscanthus japonicus*. Oogonia are found only on the last three species. Local distribution is accomplished through the dispersal of conidia by night breezes of varying strength. Since the conidia can not survive drying, spread to distant countries must take place through the transportation of oogonia either in soil or adherent to seeds and other plant parts, or through the transportation of infected cuttings as of sugar cane. These and other points bear on the problem of pathological procedure against foreign diseases.

A bacterial root and stalk rot of field corn. H. R. ROSEN.

A disease of field corn has been observed in widely scattered localities in Arkansas which at times renders useless or kills twenty to thirty per cent of the stalks. The disease is characterized by a rotting accompanied by a light or dark-brown discoloration of the nodes, usually the lower ones. Under favorable conditions, such as a high humidity and temperature, the rot extends through the entire thickness of the stem in a few days time; the tissue attacked collapses and disintegrates, and the stalk topples over. Roots, leaf-sheaths, leaf-blades, and husks are also attacked. Eighteen varieties of field corn and one variety of sweet corn are known to be subject to the disease. Bacteria have been observed in constant association with diseased tissue. Numerous

isolations reveal a white, motile, rapidly growing, rod-shaped bacterium. Pure cultures of the organism, applied as a spray in water suspensions or as needle smears, produce infections on roots, stems and leaves similar to the natural ones. In the infections thus produced the organism has been found within the diseased tissue and has been reisolated.

A Fusarium wilt of corn in Iowa in 1920. J. C. GILMAN.

In Iowa a disease of corn was observed in the field when the plants were about six inches high. At this time, certain plants showed marked tip-burn of the leaves, especially the lower pair. This tip-burn was accompanied at times by wilting of the plant. Certain of these plants were pulled and upon cutting showed a brown discoloration of the vascular system at the base of the stalk. Isolations showed the presence of a Fusarium in 93 per cent of the cases. Other hills containing typically diseased plants were marked and at harvest time 85.6 per cent of these marked hills contained either barren or dwarf plants; 68.1 per cent showed barren-dwarfs present. The mortality in these marked hills was 5.8 per cent as compared with 2.1 per cent in the entire field. These two facts indicate that a Fusarium wilt was causing considerable damage to the crop. This disease corresponds markedly with the early stages of root-rot as described by Hoffer and Holbert but differs in the following respects: first, the hills which showed the wilt did not exhibit broken, leaning or down stalks at harvest time, but were most erect in the field. Down and leaning stalks throughout Iowa showed rotten roots within a short time after they fell, but these rots in the cases investigated were due to secondary saprophytes which invaded the injured plants. The breaking over was traced to soil, weather, culture, or corn root-worm injury. In the second place the presence of this wilt was not indicated by discoloration of the seedlings on the germinator, although the field in which the observations were made was planted by the ear to the row method and the ears were all observed on the germinator.

The improved rag-doll germinator as an aid in controlling root, stalk and ear-rots of corn. B. H. DUDDLESTON AND G. N. HOFFER.

The improved rag-doll germinator, developed in the corn root and stalk rot investigations conducted coöperatively by the Office of Cereal Investigations and the Purdue University Agricultural Experiment Station, has been used with marked success in detecting seed ear infections in corn. In a test of over 14,500 ears at Shelbyville, Indiana, in 1920, 27 per cent showed serious infections of Fusarium spp. and Diplodia. Twelve experimental plots in Shelby County have shown an average decrease of 11.1 per cent, or an equivalent of eight bushels per acre, when Fusarium infested ears which germinated 100 per cent were used to check against the general field planted with apparently disease-free ears. Local strains of dent corn were used in these tests. The range of difference was from 2.5 to 23.8 per cent decrease varying with the different strains of corn and conditions under which they were grown. Some of the seed stocks showed heavier infections than others and a direct correlation seemed to exist between this and the amount of reduction in yield.

Kernel starchiness as an index of susceptibility to root, stalk, and ear rots of corn. JOHN F. TROST AND G. N. HOFFER.

Starchy ears of corn of certain dent varieties produce larger numbers of weaker-growing and more root-rot susceptible plants in the field than the plants from ears more horny in composition, irrespective of whether the starchy kernels are infected with species of Fusarium before planting. An experimental test of over 2000 seed

ears supplied in groups of 100 each by prominent Indiana seed corn growers shows that seed ear infections occur in an increasing gradient according to the degree of starchiness of the ears of the various strains. Results from an experimental ear-row plot at Bedford, Indiana, in 1920, wherein only apparently disease-free starchy and horny ears of a yellow dent strain were used, show that the average reduction in initial stand was 4 per cent and in yield 16.4 per cent for the various rows planted with the starchy ears in comparison with the average stand and yield for the rows planted with the ears of horny composition. (Coöperative investigations by the U. S. Office of Cereal Investigations and the Purdue University Agricultural Experiment Station.)

Three methods of controlling the root, stalk, and ear rots of corn. G. M. SMITH AND G. N. HOFFER.

Field selection of seed ears of sweet corn from apparently healthy stalks, artificial drying by heat immediately after harvesting the ears, and testing seed ears for germination and infection in the improved rag doll germinator are three methods, any one of which, or all combined, have been found profitable in reducing the amounts of seed-ear infections with Fusarium spp. which cause losses in this crop when used for canning purposes. Field-selected ears of Stowell's Evergreen from vigorous healthy stalks yielded 10 per cent more than the bulk selected ears from the same field. An experimental test of ten artificially dried seed lots averaged 14.6 per cent greater initial stand, 35.5 per cent less barren stalks, and 18 per cent higher yield than the average of 22 plots wherein naturally-cured ears were used. An average of 10 plots in which both apparently disease-free and diseased seed ears were used gives a reduced yield of 9.8 per cent per acre for the diseased seed ears. (Coöperative investigations by the U. S. Office of Cereal Investigations and the Purdue University Agricultural Experiment Station.)

Resistance as a basis of control of corn root rot. W. D. VALLEAU.

A study of the extent of ear and seed infection, carried on at the Kentucky Agricultural Experiment Station, on 39 varieties of corn from 27 localities in the United States, indicates that ear and seed infection with *Fusarium moniliforme* is probably universal. No disease-free ears or lots of shelled corn have been found. Ear to row tests were conducted, using the 69 ears reported on in Table I, Bul. 226, Kentucky Agricultural Experiment Station. One month after seeding, 1570 of 1575 plants examined showed distinct nodal discolorations. Records made between October 10 and 15, after the ears were ripe and before a killing frost, showed 1149 of a total of 5036 plants to have died prematurely, an average of 22.8 per cent. There were striking differences in the greenness of the live plants from the various ears. The differences in time of death of the various plants were due to differences in degree of resistance to root rot which each possessed. Ears of corn selected for seed purposes may be graded as to the relative degree of resistance which plants from them show when grown in the sand box germinator. The same relative degree of resistance will be shown when ear to row tests are conducted in the field. Forty-six per cent of the plants from the most susceptible ears selected from 100 seed ears were prematurely dead on October 11, while only 9.3 per cent of those from the most resistant ears were dead at that time. All of the plants from the susceptible ears died before frost, while the live ones from the resistant ears remained alive and green until killed by frost.

Selection of disease-free seed and seed treatments as possible means of control of corn root rot. W. D. VALLEAU.

Ears were selected at various periods from the early dough stage to maturity in an attempt to obtain disease-free seed. Thus far no disease-free seed has been obtained by this method. The results obtained indicate that infection takes place before the early dough stage. It probably occurs through the silks and is a result of infection of the exposed silk mass with *F. moniliforme*. Attempts to control corn root rot by seed treatment have given negative results. Various modifications of the hot water treatment and soaking in various chemicals including formalin, copper sulfate, mercuric chloride, Bordeaux mixture, ammoniacal copper carbonate, commercial lime sulfur, barium thiosulfate, calcium thiosulfate, sodium hyposulfite, potassium polysulfide, sodium bisulfite and 95 per cent alcohol for periods up to seven hours have given no control of corn root rot. Practically as much injury resulted to seedlings grown in sand following these treatments as to checks. Field results also indicate that the methods tried give no promise of control.

Second progress report on the fusarium blight (scab) of wheat. JAMES G. DICKSON, HELEN JOHANN, AND GRACE WINELAND.

While Fusarium blight or scab did not occur in epidemic form in the winter wheat belt during the past season considerable losses occurred in the spring wheat area, especially in Wisconsin, Minnesota and South Dakota. In 1920 two hundred specimens were received from sixteen central and eastern states. Ninety-eight per cent of these yielded *Gibberella saubinetii* (Mont.) Sacc., as contrasted with 94 per cent in 1919. About 2 per cent of the specimens each year gave *Fusarium avenaceum* (Fr.) Sacc. *F. culmorum* var. *leteius* Sherb. was isolated from a few specimens in 1919, but was not found on the specimens collected the past season. Isolations for the two seasons showed *G. saubinetii* to be the most common organism, although the season of 1920 was much drier than the preceding one. The great difference in perithecial development for the two seasons—51 per cent of the specimens in 1919 and 15 per cent in 1920—suggests that perithecial development in *G. saubinetii* is closely associated with moisture. Results from about 400 field inoculations with pure cultures of the previously mentioned organisms and *F. culmorum* (W. G. Sm.) Sacc. indicate that the highest percentage of infection with all of the organisms occurs during the period of flowering. Initial infection usually occurs through the extruded anthers. After the fungus has become established, it spreads to adjacent tissues. Subsequent rapid progress of the blighting depends upon three or four days of continued warm, humid weather. (Coöperative investigations by the U. S. Office of Cereal Investigations and the Wisconsin Agricultural Experiment Station.)

The influence of soil temperature on the development of the seedling blight of cereals caused by Gibberella saubinetii. JAMES G. DICKSON.

The seedling blight of winter wheat caused by *Gibberella saubinetii* (Mont.) Sacc. has been noted most commonly in early sown fields. This parasite has been found to attack corn seedlings also.

Parallel series of clean and infected wheat and corn seedlings have been grown under greenhouse conditions in loam soil held at eight constant soil temperatures at four degree intervals from 8° to 36° C. Uninfected wheat seedlings developed the largest root systems and the heaviest total dry weight at soil temperatures below 16° C. On the other hand, corn seedlings produced the largest root systems and greatest total dry weight at soil temperatures above 20° C. Wheat seedlings from naturally infected

(scabbed) wheat as well as clean seed artificially inoculated did not blight at soil temperatures below 12° C.; severe blighting occurred from 16° to 28° C.; only very little at 32° C., which is about the maximum temperature for the development of the organism, and none at 36° C. On the contrary, corn seedlings from clean seed inoculated with the parasite blighted badly at the soil temperature of 20° C., and below, and did not blight above 24° C. Periodic field plantings using scabbed wheat and clean, inoculated seed and clean seed uninoculated were made from March to June, 1920, at Madison, Wisconsin. In March and April plantings, when the soil was cool, the scabbed and inoculated seed and controls each produced an average of 76 per cent stand. In May plantings, when the soil was warm, the scabbed and inoculated seed produced 32 per cent stand and controls 77 per cent. These field results correlate with greenhouse experiments summarized above. (Coöperative investigations by the U. S. Office of Cereal Investigations and the Wisconsin Agricultural Experiment Station.)

Growth and germination of Gibberella saubinetii at varying hydrogen-ion concentrations. E. F. HOPKINS.

The effect of acidity on the growth of the wheat scab organism was determined in three series of liquid cultures using a synthetic medium in which the H-ion concentration was adjusted by means of KH_2PO_4, K_2HPO_4, H_3PO_4 and KOH. The pH values were determined colorimetrically both at the beginning and end of each experiment. The dry weights of the mycelial mats were taken at the end of four, seven and fourteen days. In all three series the amount of growth increased with decreasing acidity from pH 2.5 to a maximum at pH 4.0–4.5. It then decreased to a minimum at pH 5.0–5.5 and rose again to a second maximum, the highest point of which was not determined. When NaOH and H_2SO_4 were used to adjust the reaction results were obtained which substantiated those just mentioned. A culture of a Fusarium, not proved to be Gibberella but isolated from scabby wheat, showed a similar depression in the growth-acidity curve.

Using solutions prepared as above, the effect of the hydrogen-ion concentration on spore germination of *Gibberella saubinetii* was also studied and results thus far indicate that conidial germination also shows a double maximum.

Hydrogen-ion concentration of the soil and seedling infection by Gibberella saubinetii. E. F. HOPKINS.

The reaction of the soil in seventeen flats in the greenhouse was adjusted to varying degrees of acidity by means of N/1 NaOH and N/1 H_2SO_4, which were thoroughly mixed with the soil. After standing some time in order to allow equilibrium to be reached samples were taken from each flat and the hydrogen-ion concentration determined colorimetrically. The flats were then planted with wheat seed which had been treated with a spore suspension from an authentic culture of *Gibberella saubinetii* and the surface of the soil sprayed with the same spore suspension.

Counts of the seedlings as they appeared were made and a marked depression in the curve was noted at a pH of about 5.8 at the end of four days when the number of seedlings was plotted against the hydrogen-ion exponents. Infection in the seedlings first appeared evident ten days after planting. Re-isolations from a number of diseased seedlings produced typical cultures of the organism. At the end of three weeks the greatest amount of infection showed in the most acid (pH = 2.5–3.0) and most alkaline (pH = 3.4–4.0) soils with a minimum in the curve at a pH of about 5.5. This minimum appears to correspond with a minimum in the growth-acidity curve of the

wheat scab organism. Two flats of soil of a pH = 6.4, the original soil, uninoculated showed a perfect stand with no diseased seedlings.

The so-called take-all disease of wheat in Illinois and Indiana. H. H. McKINNEY.

This disease recurred in Madison County, Illinois, and in Porter County, Indiana, in 1920. In Illinois the disease was severe in 1920 but was less extensive than in 1919. This was probably due to the fact that the majority of farmers did not sow the few varieties which showed the disease the previous year. The first indications and characteristic symptoms of the disease consist in retarded spring development followed by excessive tillering. No lesions or organisms were found constantly associated with the disease during this early spring stage. A little later, lesions develop and a species of Helminthosporium has been found rather closely associated with the disease, and there is a suggestion that so-called take-all in Illinois and Indiana may be an unusual manifestation of the Helminthosporium disease of wheat present in many sections. While pathogenicity tests have shown the Helminthosporium to be pathogenic on wheat, this organism has not yet produced the characteristic field symptoms of the so-called take-all. Further work is necessary before the cause of this disease can be definitely assigned to this organism. The most promising means for controlling the disease as it is understood at present lies in the use of resistant varieties. Red Wave and May varieties and a strain of Turkey are, thus far, not susceptible to the disease, while the white chaffed, red-kerneled type of Red Cross (Salzer's Prizetaker) and Illini Chief are very susceptible. These investigations were conducted by the Office of Cereal Investigations at Granite City, Ill., and Madison, Wis.

Helminthosporium and wheat foot-rot. F. L. STEVENS.

In an adaptation of the rag-doll seed tester, which allows of the use of seedlings under aseptic conditions and variation of moisture and temperature as desired, inoculation by spores of *Helminthosporium* upon the uninjured sheath was followed within 24 hours by entrance of the mycelium into the host cells, and within 48 hours by a browned, diseased spot visible to the naked eye. Subsequently, when conditions favored, the mycelium invaded the innermost leaves and caused general rotting and death. When inoculated upon roots there was general invasion of the cortex with very slight discoloration. Aside from the Helminthosporium originally isolated several variant, closely related types have been isolated that have the same infecting ability, which is also possessed by all (many) cultures sent to me under the names *H. teres*, *H. avenae*, *H. gramineum* and even *H. interseminatum*. Infection is through the middle lamellae. The mycelium forms appressoria, the middle and inner lamellae adjacent to it swell, and they and the adjacent cellulose walls change in stain reactions. On the inside of the host cell callus-like bodies develop. Similar results are had in inoculations in soil. A geniculate spored Helminthosporium produced abundant mycelial invasion but extended to only a few cells. An Alternaria common on wheat grains produces the early symptoms of infection but was not seen to gain entrance to the wheat cells. Infection by the foot-rot Helminthosporium was secured on corn, barley, rye, corn-fodder, Sudan grass and millet.

The effect of certain chemicals especially copper sulfate and sodium chloride on the germination of bunt spores. NOEL F. THOMPSON.

Experiments were conducted at Pullman, Wash., and at Madison, Wis., to determine the concentration of the solution and the length of treatment necessary to cause the death of bunt spores (*Tilletia tritici* (Beij.) Wint. and *T. laevis* Kühn). The chem-

icals and the concentrations generally employed in seed treatments were used and also various dilutions and combinations of these. Finely sifted spores were agitated in a relatively large amount of the solution. The spores were then caught on filter paper and, after drying, were transferred to the surface of moist soil to germinate. The following table gives the relative amount of germination of *T. triciti* spores after ten-minute treatments with different chemicals. O indicates no germination, 1, a very small per cent, 2 and 3, intermediate, and 4, an abundant germination.

CHEMICAL	STRENGTH LBS. TO GALS.	RELATIVE GERMINATION DURING SIXTEEN DAYS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Water		0	0	0	2	4											
NaCl	1–5	0	0	0	2	4											
CaO	1–5	0	0	0	2	4											
$CuSO_4$	1–5	0	0	0	0	1	3	4									
$CuSO_4$ and NaCl	1–1–100	0	0	0	0	0	0	0	0	0	0	1	1	1			
"	1–1–50	0	0	0	0	0	0	0	0	0	0	2	2	2			
"	1–1–25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
"	1–1–5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HCHO	1–160	0	0	0	0	0	0	0	0	2	3	3	4				
"	1–80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
"	1–40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2

The strongest copper sulfate solution used did not inhibit growth but only retarded it. This was true whether the treatment was one minute or one hour. A relatively dilute solution of copper sulfate and sodium chloride practically inhibited all growth. The results with *T. laevis* were essentially the same as with *T. triciti*.

Chemical dusts for the control of bunt. W. W. MACKIE AND FRED N. BRIGGS.

The writers, confirming the results of other investigators, have shown that the commonly employed methods of seed disinfection involving the use of bluestone and formaldehyde frequently are injurious to the germination of the seed and to the development of the seedling. Further, where the season for seeding grain is very short, the present treatments interfere with seeding operations and cause the loss of valuable time because the seed cannot be treated previous to the seeding period. In case seeding is interrupted by rain any treated seed stored damp may be damaged. Since 1918, the writers have conducted experiments with flowers of sulphur and the dusts of copper sulphate and copper carbonate for the prevention of bunt. All experiments were made with Little Club wheat, inoculated with *Tilletia tritici* and sown in rod rows which gave an average of over 500 heads. Sowings were made in duplicate. In 1919, flowers of sulphur gave the following results where quantities of one-half to two quarts were mixed with 140 pounds of seed.

TREATMENT				SMUTTED HEADS AVR. PER CT.
Seed heavily smutted.			Not treated	84.1
"	"	"	Mixed with flowers of sulphur	41.5
"	"	"	Bluestone (1–4)	21.9

In 1920 flowers of sulphur gave the following results when 25 to 100 pounds were mixed with 100 pounds of seed:

TREATMENT			SMUTTED HEADS AVR. PER CT.
Seed smutted			
1:750 by weight.		Not treated	61.8
"	"	Sulphur*	6.3
"	"	Bluestone (1–4)	.2
"	"	Formaldehyde (1–4)	.0

* Varying amounts of sulphur gave practically the same reduction in smut.

In 1920, results from copper sulphate and copper carbonate dusts applied at the rate of two ounces per bushel were as follows:

TREATMENT			SMUTTED HEADS AVR. PER CT.
Seed smutted			
1:750 by weight.		Not treated	6.2*
"	"	Dusted with copper sulphate plus calcium carbonate (1–1)	.0
"	"	Dusted with copper carbonate	.0
"	"	Bluestone (1–4)	.1
"	"	Formaldehyde (1–40)	.0

* Low per cent of smut in check rows was due to late sowing.

The results reported in this abstract were obtained by the California Experiment Station in coöperation with the U. S. Office of Cereal Investigations.

The regional occurrence of Puccinia graminis on barberry. E. C. STAKMAN, R. S. KIRBY AND A. F. THIEL.

It has been observed frequently that the common barberry does not rust in the Southern States and on the Pacific Coast. The Office of Cereal Investigations of the United States Department of Agriculture, coöperating with State experiment stations, undertook to ascertain the limits of barberry infection and to determine why infection did not occur in the South. It was found that east of the Rocky Mountains barberry infection is most prevalent and most severe north of 40 N. lat., although at high elevations in certain regions there was heavy infection as far south as 37°. The line representing the southern limit of the barberry infection area is quite irregular. It was found that barberries would not become infected in the Southern States when they were inoculated with teliospore material which had been developed in the South. On the other hand, when they were inoculated with teliospores from the North, they became very heavily infected. Excellent infection was obtained as early as March 16, by using northern material. Teliospores from the South which had been kept in the North during the summer and fall, however, caused infection in the South, while north-

ern teliospores which had been kept in the South did not cause infection. Teliospores formed in the fall in the South caused infection the following spring. Numerous germination tests were made and the results of the germination tests correlated with the facts observed regarding infection. Evidently, therefore, the reason why barberries do not become infected in the South is not because conditions are unfavorable for infection, but because practically no teliospores are viable in the spring.

The aecidium of the orange leaf rust of wheat, Puccinia triticina. H. S. JACKSON AND E. B. MAINS.

In the spring of 1919, ten collections of wintered telia of *Puccinia triticina* were germinated and sown on 48 species included in 19 genera of the families Ranunculaceae, Boraginaceae, and Hydrophyllaceae. The results were negative except in the case of two species of Thalictrum, upon which pycnia were produced. In the spring of 1920, 37 collections of wintered telia were germinated and sown upon 14 species of Thalictrum. Infection resulting in the development of pycnia or aecia was obtained in 84 instances upon 12 of these species. The most vigorous development of aecia was obtained on four exotic species. Infection was only occasionally obtained on the native species used with but a weak development of aecia. The collections of telia giving infection were from Pennsylvania, West Virginia, North Carolina, South Carolina, Alabama, Georgia, Mississippi, Tennessee, Kentucky, Indiana, Michigan, Illinois, Minnesota, Iowa, Missouri, Louisiana, Texas, Arizona, California, Washington, and Idaho. Aeciospores obtained from 20 of these cultures were sown back upon seedling wheat, producing in every case uredinia typical of *Puccinia triticina.* (Coöperative investigations by the Purdue University Agricultural Experiment Station and the U. S. Office of Cereal Investigations.)

Two strains of Puccinia triticina on wheat in the United States. E. B. MAINS AND H. S. JACKSON.

Shortly before harvest in 1919, certain varieties of wheat showed a high degree of resistance to *Puccinia triticina* as grown in the wheat nursery at La Fayette, Indiana. These included Kanred (P. 762), P. 1066 (Kans., 2415) P. 1068 (Kans. 2414), and four selections of a hybrid, Turkey x Bearded Minnesota, received from the Kansas Experiment Station, together with Malakoff, C. I. No. 4898. When certain uredinial cultures of this rust were sown on seedlings of these varieties in the greenhouse a difference in reaction was noted. Kanred, P. 1066, and P. 1068, were fairly heavily infected by all cultures in the seedling stage. The explanation of this has been found to be due to a difference in the susceptibility of these varieties according to maturity. They are moderately susceptible in the seedling stage, becoming highly resistant as they mature. The varieties Malakoff and the four Turkey x Bearded Minnesota hybrids, however, reacted differently, showing resistance in the seedling stage to all but two of the cultures used. These two cultures were obtained from Murfreesboro, Tenn., and Normal, Okla., and were found to infect the Malakoff and Turkey x Bearded Minnesota selections fairly heavily. During 1920, a number of additional uredinial cultures were sown on these five varieties, resulting in a separation of these cultures into two groups by their ability or inability to infect selections of Malakoff and Turkey x Bearded Minnesota. In field sowings a somewhat similar differentiation of *P. triticina* into two strains has been noted. Both strains have also been obtained from the aecia of this rust developed on Thalictrum. (Coöperative investigations by the Purdue University Agricultural Experiment Station and the U. S. Office of Cereal Investigations.)

The nematode disease of cereals. A. G. JOHNSON AND R. W. LEUKEL.

In experiments covering two years at the Arlington Farm of the United States Department of Agriculture, Arlington, Virginia, this disease has been found to attack wheat, rye, emmer and spelt severely. Although, in a few cases, rudimentary galls formed on oats and barley, these two cereals have proved to be practically immune. Byars found that the nematode (*Tylenchus tritici*) remained alive for over ten years within the dry galls. The nematodes from ground galls have been kept in a dry place for over a year and are still alive. In moist soil, they die in less than a year. Soil badly infested in 1918 was sown to grass for a year and wheat sown in the fall of 1919 did not become infected. Dissemination is chiefly through infested seed and straw. In our experiments the nematodes moved horizontally in the soil only about four inches. Vertically, however, they moved up from a depth of twelve inches. The first symptoms of the disease in the field become evident in the fall about three weeks after the wheat is sown. This shows definitely that general infection of winter wheat occurs in the fall under Virginia conditions. This varies from the supposed condition in Germany where, as stated by Marcinowski, infection takes place in the spring. For two years a series of twenty-five wheat varieties have been tested for relative susceptibility. Only one, namely Kanred, has shown consistent resistance. The different varieties of emmer, spelt and rye showed rather high susceptibility. Control measures require clean seed, rotation, and keeping infested material off land at least one year previous to sowing wheat.

Loss from rye ergot. EDITH K. SEYMOUR AND FRANK T. MCFARLAND.

Observations and exact counts, initiated by Dr. L. R. Jones in 1918 and continued during 1919 and 1920, show that the loss caused by ergot (*Claviceps purpurea* (Fr.) Tul.) in rye is represented not only by the actual number of sclerotia but also by a large number of blasted kernels and empty florets. These blasted kernels and empty florets, present in ergotized and unergotized spikes, are always greater in number in the ergotized spikes. Of 730 ergotized spikes 47 per cent of the florets either held blasted kernels or were empty and 10 per cent held sclerotia. Of 651 unergotized spikes only 31 per cent of the florets either held blasted kernels or were empty. Verification of the wide penetration of the fungus through the diseased spikes was shown in 24 spikes by the abundance of conidia in 70 per cent of the florets, of which only 21 per cent showed sclerotia. The average length and weight of the ergotized spikes was compared with that of the unergotized spikes. In all cases but one the diseased spikes were shorter in length and lighter in weight. (Coöperative investigations by the Wisconsin Agricultural Experiment Station and the U. S. Office of Cereal Investigations.)

Infection experiments with Claviceps. FRANK T. MCFARLAND.

During the summer of 1920 careful cross inoculation experiments were performed to ascertain, if possible, the interrelations of the ergots (Claviceps) of the different grasses and cereals. While the results obtained thus far are somewhat fragmentary, it is deemed wise to give a preliminary report at this time. Successful inoculations from rye upon rye have easily been secured. In these trials with rye equally good results have been obtained by using conidia from any of three sources: (1) the honey dew from ergotized florets, (2) the surfaces of mature sclerotia, (3) pure cultures from agar slopes. In all cases success was limited to infections made when the floral glumes were wide open, negative results following inoculations made at both earlier and later stages. Successful inoculations have been secured upon rye with Claviceps conidia

from the honey dew stages of each of the following: *Bromus inermis, Agropyron repens, Poa pratensis,* and *Arrhenatherum elatius.* With wheat it has been more difficult to secure infection, although positive results in a few cases have come when conidia were used from either rye, *Arrhenatherum elatius, Poa pratensis,* or *Agropyron repens.* Pure cultures of the rye strains also gave infection. In general cross inoculations have given a higher percentage of success where made from one of the above grass species to another than where made from grass to rye.

Occurrence of Rhyncosporium on Dactylis glomerata and Bromus inermis. CHARLES DRECHSLER.

At Madison, Wis., during the month of May, 1920, *Rhyncosporium secalis* (Oud) Davis was found attacking *Dactylis glomerata* and *Bromus inermis,* the lesions produced being altogether similar to those characteristic of the disease of rye and barley caused by the same fungus. As the individual plants of *Dactylis glomerata* found affected were relatively few in number, this host, perhaps, cannot be regarded as a highly congenial one. On *Bromus inermis,* however, the lesions were moderately numerous, the disease here being present in the same degree of abundance as on rye and barley growing in the vicinity. No records of the occurrence of the parasite on these two hosts either in America or elsewhere has been found. (Coöperative investigations by the Wisconsin Agricultural Experiment Station and the U. S. Office of Cereal Investigations.)

Two sclerotium diseases of rice. W. H. TISDALE.

Studies by the U. S. Office of Cereal Investigations at the Rice Experiment Station, Crowley, La., revealed two unreported Sclerotium diseases of rice, namely:

(1) Seedling blight (*Sclerotium rolfsii* Sacc.). Blighted seedlings observed at Crowley, La., June 12, 1919. Destructive to germinating seed and young seedlings. Stand of plants decreased as much as 50 per cent on inoculated soil. Strains of *S. rolfsii* from soy bean and oat grass produced very little effect on the stand of rice, while a strain from wheat was as parasitic as the rice organism. Sclerotia survive winter weather and irrigation. Irrigation checks the disease. Cultivation reduces amount of fungus in soil.

(2) Stem rot (*Sclerotium oryzae*) Catt.?) Cattaneo described *S. oryzae* in Italy in 1877. Sclerotia smaller than the American form. Miyake reported *S. oryzae* Catt. as causing a serious disease in Japan in 1909. Found at Crowley, La., on old rice straw in spring of 1919. Noted as serious disease of Early Prolific rice August 5, 1920. Found in other varieties later. Fungus attacks stems at the water line. Plants weaken and lodge easily. Grain fails to fill normally. A fine, white mycelium and numerous spherical, black sclerotia, 250 microns in diameter develop in the stem cavity and diseased tissues.

Rice straighthead and its control. W. H. TISDALE AND J. MITCHELL JENKINS.

For the past two years the U. S. Office of Cereal Investigations has been conducting experimental work at the Rice Experiment Station at Crowley, La., on "straighthead," a physiological disease, which annually causes serious damage to the southern rice crop. The disease is characterized by sterile or partially sterile panicles which stand straight. The leaves are darker green and somewhat stiffer than normal. Flower parts fail to develop in various degrees. The single sickle-shaped glumes are characteristic. The disease is more prevalent on virgin soil and on soil that has been planted to dry land crops in immediately preceding years. Apparently certain stages of the

decay of organic matter leaves the soil in such physical condition that practically all the air is excluded when water is applied. A large system of primary roots develops but few secondary roots and root hairs. Thus normal nutrition is upset. If the soil is drained during certain parts of the irrigation period so as to permit root aeration, normal root systems develop and a good crop of rice is produced. If, however, this type of soil is not drained, serious damage may be expected from "straighthead."

The control of peach brown rot and curculio. J. A. MCCLINTOCK.

In the coastal plain of Georgia neither sprays nor dusts control curculio or brown rot satisfactorily. Data were collected at fourteen commercial peach orchards, totalling over 300,000 trees. An average of 50 per cent of the fruit was wormy and there was 10 per cent of brown rot on uninjured fruit. Adjoining plats of 300 trees each gave the following results:

Plat 1: sprayed 4 times with atomic sulphur, 20 gallons; lime, 20 lbs.; powdered arsenate of lead, 3 lbs.; and water, 200 gallons gave 59 per cent wormy, 15 per cent wormy and rotting, 1 per cent rotting, no scab, and 25 per cent sound fruit.

Plat 2: dusted 4 times with 80 per cent sulphur, 15 per cent lime, using 100 lbs. of dust to 500 trees at an application, gave 68 per cent wormy, 6 per cent wormy and rotting, 1 per cent rotting, no scab, and 25 per cent sound fruit. In isolated orchards of the coastal plain section three applications of spray resulted in 10 per cent wormy and less than 1 per cent rotting fruit.

Blossom blight of the peach. MEL. T. COOK.

This disease is due to *Sclerotinia cinerea* (Bon.) Schrot. It was exceptionally severe in New Jersey in 1919 and also very severe in 1920. It is much less severe on young than on old orchards, but apparently has no connection with the mummied fruits. It was very severe in the state experimental orchards from which rotten fruits of the preceding year had been removed. It apparently spreads from cankers formed on the wood of the preceding year. Twigs that are completely girdled wither and die. The vitality of those that are partially girdled is greatly reduced. Cankers on the older wood are of little importance. The cankers are easily confused with scab cankers. The disease can be greatly reduced by the pink bud spray.

Second progress report on apple scab and its control in Wisconsin. G. W. KEITT.

During the past season the work on apple scab was continued and extended, special attention being given to studies of the development of fungus, host, disease, and control, and to climatic conditions.

The discharge of ascospores of *Venturia inaequalis* (Cke.) Wint. was carefully followed at Madison and Sturgeon Bay. At Madison the first discharge was noted on April 23 and the last on June 12. The heaviest discharges occurred between May 11 and May 24. The apple buds separated in the clusters about May 17–19. Developments were probably considerably influenced by a dry period from May 1 to May 9.

At Sturgeon Bay the first ascospore discharge was noted on May 20 and the last on June 30. The heaviest discharges occurred between June 8 and June 17. The apple buds separated in the clusters about May 29–30. Developments were probably considerably influenced by a long dry period in early May and another from May 24 to June 6.

At Sturgeon Bay lime-sulphur (liquid) and Bordeaux mixture controlled scab satisfactorily when applied comparatively according to the standard four-spray schedule: (1) May 29–30 ("pink"), (2) June 9, (3) June 21–22, and (4) August 6. An additional

early treatment on May 24 was of little value, due to the unusually long dry period which followed. The development of scab during the season was less severe than usual.

Leaf scorch or mollisiose of strawberry. R. E. STONE.

A very common disease of the cultivated strawberry is found in nearly all districts of southern and eastern Ontario. It is of most importance the second year after transplanting, making the plants weak and unable to successfully winter over for the second crop. In early stages the leaves show irregular purple spots. These enlarge and coalesce, involving the entire leaf, and may also be found on the petiole. Later the spots become cinereous and the leaves take on a dried scorched appearance. Whole plants and often the entire patch appear as though burned over by fire. An examination of the purple spots and cinereous areas shows the presence of sub-cuticular acervuli containing hyaline, muticate, two-celled spores. The fungus has in the past been called *Marssonia potentillae* (Desm) Fisch. Inoculations with pure culture from these spores produce the typical disease. *Marssonia potentillae* (Desm) Fisch. may winter over in the conidial stage of green leaves and may even be found in viable condition on dead leaves. On the dead dry leaves that have been attacked by this organism an ascigerous stage develops. This ascigerous stage has been determined as *Mollisia earliana* (E. & E.) Sacc. The following facts show the relations of the two forms:

(1) The Mollisia follows the Marssonia.

(2) Strawberry plants infected with ascospores developed the Marssonia spot.

(3) Ascospores planted singly develop Marssonia colonies in culture.

(4) Marssonia developed from single ascospores is capable of infecting the strawberry leaves, giving rise to typical leaf scorch.

Since *Mollisia earliana* is the perfect or ascigerous stage of the fungus, the causal organism should be referred to as *Mollisia earliana* (E. & E.) Sacc.

Rhizopus sp. associated with a decay of unripe strawberries in the field. L. E. MELCHERS.

In 1919 and 1920, the writer observed that unripe strawberries in the field were being attacked by Rhizopus. The fruit was about three-fourths grown, and the berries were in the white stage (just before the berries show a pink or red color). Wherever the berries touched the soil infection occurred. The decayed spots became soft and slightly brown. In some fields from 25 to 35 per cent of the fruit was unsalable. Seasonal conditions without doubt have a great influnece on the occurrence of this trouble. A few days to a week of cloudy, wet weather, just before the berries begin to turn pink, is the most favorable for infection. A few bright days will stop this injury. Prior to 1919, no report seems to have been made which shows that Rhizopus has been found on unripe fruit in the field.

Tissue breakdown in fruits and vegetables. RAY NELSON.

Certain market fruits and vegetables are seriously affected with a disease in which lesions of various kinds occur. The diseases known as "black leaf speck" of cabbage, "red heart" of Iceberg lettuce, and various surface spots of grapefruit, orange and lemon belong in this group. The disease may be classed as a tissue breakdown and commonly occurs under conditions of poor ventilation in storage and transportation. It has been reproduced typically for all of the above hosts by imitating the conditions prevailing in transportation and storage.

The effect of incipient decay on the mechanical properties of airplane timber. REGINALD H. COLLEY.

Standard tests conducted at the University of California by the Bureau of Plant Industry in coöperation with the U. S. Forest Service indicate marked differences in the effect of different fungi on the mechanical properties of airplane timber. Pieces of Sitka spruce and Douglas fir showing incipient decay were tested against matched sound pieces. The effect of *Fomes pinicola*, *Fomes laricis* and *Polyporus schweinitzii*, which may be grouped together, was decidedly more marked than that of *Trametes pini*. Test sticks taken many feet ahead of the typical rot showed the weakening effect of *P. schweinitzii*, while sticks infected with *T. pini* gave as high or higher results than sound wood. Lumbermen have long recognized that wood infected with *T. pini* is strong even in the early pocket stage. Interpretation of results is difficult. Correction constants figured for sound wood are probably inapplicable to infected wood. Such variables as resin infiltration which raises the specific gravity of an infected stick above the normal specific gravity for sound wood must be considered. Results point to need for more careful inspection and diagnosis of incipient decay in forest and mill to prevent the expense of working and finishing defective stock and its inclusion in the airplane.

Valsa poplar canker. ALFRED H. W. POVAH.

This disease, under the name *Cytospora chrysosperma* (Pers.) Fr. has been reported from the Southwest by Long and from the Northwest by Hubert. It has been found near Syracuse, N. Y., to cause serious injury and in some cases death to *Populus tremuloides* and *P. grandidentata* when weakened by fire. Field studies show infection of 68.4 per cent and mortality of 36.9 per cent. The perfect stage (*Valsa sp.*) has been found on the trunks of infected trees. Inoculation experiments with pycnospores on cuttings of *P. tremuloides*, *P. grandidentata* and *P. caroliniana* have resulted in the production of typical pycnia, bearing the characteristic red spore horns, and the death of the cuttings. Cuttings not inoculated but kept in the laboratory where material bearing spore horns was exposed soon became infected and were killed.

Notes on the Peridermiums of pines in Colorado and California. ELLSWORTH BETHEL.

The writer gives a summary of his observations, and culture work on western Peridermiums, covering a period of more than a score of years. New aecial hosts are recorded for *Peridermium filamentosum* Pk., *P. stalactiforme* Arth. & Kern, and *P. Harknessii* Am. Auct., and it is shown that these rusts have the same telial hosts, namely, species of Castilleja, Orthocarpus, Pedicularis, Adenostegia, and other genera of the Scrophulariaceae. The hosts, habit, and distribution of *Uredo coleosporioides* Pk. have been studied for many years, and the conclusion reached that it may represent the uredinial stage of any one, or all of the three forenamed caulicolous Peridermiums. Many important facts are given relative to *Peridermium cerebrum* Pk. in California, including its Cronartium on oak, the results of cultures, and data pertaining to its life cycle. Its range has been extended to the Mexican border, and new aecial and telial hosts are added. *Coleosporium ribicola* (C. & E.) Arth. and *C. solidaginis* (Schw.) Thum. are discussed. The range for both rusts has been extended, and new telial hosts are recorded. The writer exhibited a number of interesting specimens of Peridermiums to show the initial point of infection, and the time required to produce aecia; also specimens showing the nature of Cronartium uredinia blisters on Ribes, Quercus, and Castilleja, by which means the Cronartiums overwinter.

Investigations to determine the identity of a cronartium on Ribes in California. ELLSWORTH BETHEL AND GILBERT B. POSEY.

Extensive explorations were conducted by the writers the past season in California, to determine the identity and potentiality of a widely distributed Cronartium on native currants and gooseberries. Further investigation of the two large areas found in 1919 indicate that it all belongs to the pinon blister rust, *Cronartium occidentale* Hedgc., Bethel & Hunt. In the northern region from Mono Lake, Cal., to Minden, Nev., the Cronartium is ubiquitous on Ribes in the forests of *Pinus monophylla* Torr. In this region the attack of the Peridermium on pinon pines probably surpasses in virulence that of any other known Peridermium, differing in this respect from the very rare and feeble attack as found in Colorado. Sugar pine and other white (5-needled) pines, growing in close association with both the aecial and telial stages of the rust, were found to be free from the disease. In the southern region about Monrovia, and Pasadena, Cal., the rust seldom produces telia, and these so poorly developed as to be scarcely functional. However, the uredinial infection is so heavy as to cause an early defoliation of the Ribes plants. Investigations by the senior writer in February indicate that the rust overwinters largely, if not entirely, in the form of uredinial blisters on leaves which survive through the winter, thus obviating the necessity of an alternate host. Thus far no evidence has been obtained of the presence of *Cronartium ribicola* on the Pacific Coast.

Lightning injury in Hevea brasiliensis. CARL D. LARUE.

Lightning rarely manifests itself on the Para rubber tree (*Hevea brasiliensis*) in tearing or breaking of the trunks or branches. Usually a single small branch at the top of the tree dies first. From this point the death of the branch continues downward until the trunk is reached, then the trunk dies back until the root is reached and finally the whole tree is killed. Several days may elapse from the time the injury is first visible until the whole tree is dead. The progressive death of the tissues is extremely suggestive of invasion of the tree by some destructive organism. The injury has been attributed to Diplodia and the supposedly guilty organism named *Diplodia rapax*. Cultures by the author showed Diplodia to be the only organism constantly present but this is now known to be secondary and not the cause of the death of the tree. The injury is most pronounced in the cambium region. Here the tissue becomes a deep purple in color and decays with great rapidity, making it easy to trace the progress of the injury. The purple coloration is regarded by the author as diagnostic for this type of injury. Frequently trees surrounding the dying tree show injury in a lesser degree which develops later than the tree most seriously injured, thus suggesting the spread of an organism from one tree to the others.

Influence of temperature on the development of mosaic diseases. S. P. DOOLITTLE.

Preliminary experiments, while not permitting definite conclusions, indicate that temperature may influence the development of mosaic diseases. Cucumber plants were inoculated with mosaic while growing at soil temperatures ranging from 18° to 30° C., in three houses whose air temperatures were 18°, 24° and 30° C. At soil temperatures between 22° and 27° C. the percentage of infection was the same, although the incubation period increased with lower air temperatures. Increasing the soil temperature from 27° to 30° C., regardless of air temperature, reduced the incubation period from six to three days and produced a higher percentage of infection accompanied by symptoms of a new type. A few cases of mosaic developed at a soil temperature of 18° C. when the air was above 20° C., but with lower air temperatures

the disease did not develop. The suggestion that the development of diseases of the mosaic type may be influenced by climatic conditions is strengthened by field observations upon aster yellows. Aster plants growing on the same plat in 1919 and 1920 showed in the earlier year almost 90 per cent yellows as contrasted with less than 1 per cent last summer. The notable climatic differences were in temperature and moisture, 1919 being warm and moist and 1920 relatively cool and dry.

The relation of wild host plants to the overwintering of cucurbit mosaic. S. P. DOOLITTLE.

Recent investigations indicate that cucurbit mosaic is transmissible to plants outside the Cucurbitaceae and that certain of these plants may carry the disease over winter. Mosaic has been transmitted from cucumber to milkweed, *Asclepias syriaca*, pepper, *Capsicum annuum*, and *Martynia louisiana*, and from these plants to cucumber. There is also some evidence that pigweed, *Amaranthus retroflexus*, is susceptible to cucumber mosaic. Field observations indicate that the milkweed, being perennial, is probably an agent in overwintering mosaic, although apparently less important than the wild cucumber. The transmission of mosaic through the seed of the wild cucumber, *Micrampelis (Echinocystis) lobata*, is established, field observations confirming the experimental evidence. Surveys in Wisconsin and Illinois indicate that the distribution and severity of the disease is directly related to its occurrence on the wild cucumber in the same locality. During 1920 efforts were made to control mosaic by eradicating the wild cucumber over areas of one to two square miles, located in Wisconsin, Illinois, and Indiana, the latter in coöperation with the Indiana Experiment Station. In some cases the disease was but partially controlled, owing apparently to infection from mosaic milkweed, but results in other localities indicate that combined eradication of the wild cucumber and milkweed may be of practical value in controlling mosaic.

Overwintering of mosaic of annuals. J. A. MCCLINTOCK.

In mosaic diseases of potatoes, sugar cane and poke it has been proven that the causal entity is carried over in a living root or stem, but in mosaics of annuals like tobacco, pepper and tomato, where the root dies and the seed does not seem to carry the causal entity, how is the disease producing entity carried over from season to season? Thus far the writer has been unable to carry the causal entity over with sucking insects.

The relation of mosaic disease of cucumbers to pickling. MARGARET B. CHURCH.

Overwintering of mosaic on species of Physalis. R. F. CRAWFORD.

The question as to how mosaic of tomatoes lives over winter has never been definitely settled. It is generally known that it does not live over in the tomato seed. Mosaic from the tomato has been transferred to the following wild Solanums occurring in Iowa: *Solanum dulcamara*, *S. nigrum*, *Physalis longifolia*, *Nicandra physalodes* and *Datura stramonium*. These wild Solanums are commonly found growing in waste places as fence corners and vacant lots. Among these Solanums, *Physalis longifolia* and *Solanum nigrum* are most generally distributed. Mosaic occurs on all our cultivated Solanums, except egg plant, namely: on potato, tomato, pepper, and ground cherry. It occurs in the field on some of our wild Solanums, *Solanum nigrum* and *Physalis longifolia*. *Physalis longifolia* is perennial and mosaic has been transferred from its root stalks to tomatoes and peppers. This species of Physalis is therefore an especially dangerous weed about fields or gardens where cultivated Solanums are grown.

Mosaic of sugar beets. W. W. ROBBINS.

Mosaic occurs in steckling and seed beet fields of northern Colorado. Mosaic plants of the type showing mottling throughout do not occur in commercial fields except those in close proximity to affected stecklings or seed beets. In most commercial fields there is a small percentage of beets characterized by asymmetrical dwarfing and mottling. The disease apparently is not seed transmitted. The infectious principle retains its vitality in the steckling throughout the silo period. Numerous proximity studies in the field show that diseased mothers are centers of infection. Mosaic symptoms vary with the conditions of growth. Mottling is the characteristic symptom. Malformation may or may not be associated with mottling. Phloem-necrosis has been observed in mosaic leaves. An abnormal accumulation of starch in malformed mosaic leaves is a constant symptom. Affected mother beet leaves are often abnormally thick and brittle. Cases of apparent recovery from mosaic have been observed. Studies to date indicate that control measures consist in separation of steckling and seed fields.

A dry rot of the sugar-beet caused by Corticium vagum. B. L. RICHARDS.

A serious and apparently undescribed rot of the sugar-beet has been observed during the past season in a number of beet fields in northern Utah and southern Idaho. The disease, as it appears in the field, is confined to somewhat definitely delimited areas wherein every beet may become infected. The roots of the diseased beets show circular lesions characterized by very prominent alternating light and dark brown concentric rings. The disease is typically a dry rot. In the later stages a deep pocket, partly filled with a dry pulp composed of mycelium and decayed host tissue, occurs at each point of infection. With numerous points of attack the beet by harvest time may be converted into a dry pithy mass. Numerous isolations from sugar-beets, taken from a number of fields, have given what, from coöperative studies, appears to be a single strain of *Corticium vagum* B. & C. Inoculation shows this strain to be extremely virulent, and lesions have been produced on normal healthy beets with unusual uniformity. Similar inoculations with two additional strains of *Corticium vagum* obtained from other hosts have given only negative results. So far as has been observed, the fungus is confined in its early parasitic activity to the parts of the beet below the surface of the soil.

A new phoma disease of cotton. JOHN A. ELLIOTT.

A hitherto unreported Phoma disease of cotton appeared in June, 1920, in west-central Arkansas along the Petit Jean river. The disease made very rapid progress during a period of cool, wet weather. All plants were killed in small areas, in some of the more severe centers of infection; in other places the stand was greatly reduced. A change in weather conditions abruptly checked the progress of the disease and a great many attacked plants recovered. Scars of the lesions made by the disease could be found in infected fields throughout the summer. The pathogen was isolated and successful inoculations made both on wounded and unwounded tissues. High humidity is essential to the spread and progress of the disease. It attacks all parts of the plant above the soil and is very rapid in its advance through the tissues.

Treatment of tobacco seed and suggested program for control of wildfire and angular-spot. F. D. FROMME AND S. A. WINGARD.

Tobacco seed from affected seed pods, as well as that which has been artificially contaminated with cultures of the wildfire and angular-spot organisms, has been made sterile by treatment with formaldehyde, as shown by subsequent plating on nutrient

agar. The concentration found most satisfactory is a two per cent solution and the time of exposure fifteen minutes. There has been no apparent injury to germination from this treatment when followed by thorough washing and drying, and seed so treated may be stored several months if necessary. In practice a dilution of one ounce of forty per cent formaldehyde in one pint of water (approximately 2 per cent) is employed. Seed are treated in mason jars fitted with wire screen covers to facilitate washing and are dried rapidly by means of a hand centrifuge fitted with perforated seed containers. Seed treatment should be supplemented by (a) the use of new cloth for the plant bed cover or sterilization of the old cloth, (b) rotation and burning or steaming of the bed, (c) field rotation.

Inheritance of disease resistance to Thielavia basicola. JAMES JOHNSON.

Crosses have been made between varieties of tobacco which are resistant and susceptible to *Thielavia basicola* (B. and Br.) Zopf. The principal studies have been conducted with the susceptible White Burley variety and the resistant Little Dutch type. The first generation of a cross between resistant and susceptible types is intermediate in resistance. The second generation shows individuals of all grades of resistance, from those even more resistant than the resistant parent to others as susceptible as the susceptible parent. Selected individuals in the third generation may continue to vary while others seemingly breed true for the resistant character. Susceptibility is apparently the recessive condition. The inheritance of disease resistance does not seem to follow any simple Mendelian ratio but behaves in a manner which may be best explained by the multiple-factor hypothesis. Practical use is being made of these studies in introducing the resistant character into susceptible commercial types.

A new seedling disease of tobacco. C. M. SLAGG.

In June, 1918, a disease of tobacco consisting of leaf spots and stem browning of seedling plants was observed in Fayette County, Ky. Isolations yielded a fungus closely resembling *Fusarium affine* Faut. & Lamb. Inoculations with this fungus upon tobacco seedlings in the greenhouses at Madison, Wis., reproduced the field symptoms on leaves and stems. Reinoculation with single spore isolations of this fungus produced a distinct spotting and disintegration of the leaf tissues under moist conditions. The disease due to this parasite exhibits a variety of symptoms, ranging from a type of damping off, in very humid air, to a slight browning or girdling of the stems, in less humid air. The fungus grows slowly in culture, producing very little aerial mycelium, but great numbers of white to salmon colored conidia on dextrose potato agar. These conidia are hyaline, one-septate, straight or slightly curved, tapering slightly toward apex. Their size averages $3 \times 12\mu$. They are borne singly at the tips of digitoid condiophores arising usually at right angles to the septate mycelium.

Sclerotinia disease of sunflower in Manitoba. G. R. BISBY.

The occurrence of a serious disease of sunflowers cultivated for silage in Manitoba is recorded. The stems are usually, but not always, attacked near the surface of the ground, become brown or black, and soon fall over. Sclerotia are abundantly produced within the stem, and on the outer surface of stems attacked below ground. The disease is well distributed over Manitoba. Certain composite weeds, such as Iva, Canada thistle, sowthistle, and wild sunflowers were found killed in the field by this disease. The results of experiments in progress relative to the fungus, its pathogenicity, and a comparison of this disease with the one described by Lawrence in Washington has been made.

An important new disease of the cultivated sunflower. H. E. MORRIS and D. B. SWINGLE.

Cultivated sunflowers are rapidly coming into prominence as a forage crop, especially for silage. In the summer of 1920 a new disease of this crop appeared in several parts of Montana. A fungus that corresponds closely to *Sclerotinia libertiana* Fcl. attacks the roots and crowns causing the plants to wilt and quickly die. The bark about the crown and roots is killed and later is covered with a dense white growth of the fungus. Numerous large sclerotia are produced on the surface of crown and roots, and sometimes in the pith. These are black on the surface and white inside. The fungus does not fruit readily. In the field the disease was first observed on full grown plants, but inoculation of young plants with mycelium of pure cultures causes them to wilt rapidly and die. The disease spreads rapidly in the field apparently by extension of mycelium through the soil. Should this disease attack fields freely when the plants are small very heavy damage is to be expected. In this the first year of its appearance as high as 24 per cent of the plants in one field were killed. Within a month there was an increase of twenty-two per cent.

Bacterial leaf spot of red clover. L. R. JONES and MAUDE MILLER WILLIAMSON.

A bacterial leaf spot occurs commonly on the red clovers, both *Trifolium pratense* and *T. medium*, in Wisconsin and apparently widely elsewhere. Leaf spotting appears upon the young leaves in spring and with moist weather progresses upward upon each successive leaf, but is promptly checked by dry heat. Weather similarly conditions its prevalence during summer and autumn. While most characteristic on leaf blades it may attack petiole, stipule, and stem. While not demonstrated it presumably attacks inflorescence and fruit and may thus invade the seed. Apparently it commonly overwinters in the crown or bud and is chiefly disseminated by spattering water. The lesions are intervenous and may be marginal or interior. The spotting begins with minute watersoaked points which blacken as they enlarge. Owing to the limiting influence of the veinlets, they tend to elongate following these and become somewhat angular. The centers may finally dry out, become papery and rupture resulting in ragged shot-holed foliage. Bacterial exudate may occur but is not conspicuous. The organism has been repeatedly isolated since 1916, its characters studied, and its pathogenicity proven. It is a white Bacterium (Pseudomonas) with the group number 222.2323033. The complete description with name proposed for it as a new species has been submitted for publication.

Septoria leaf blight on the China aster. W. O. GLOYER.

Certain commercial plantings of the China aster, *Callistephus chinensis*, in New York, have been severely attacked by *Septoria callistephi* n. sp. The disease was first observed in 1915 and again in 1919 and 1920. In unsprayed plantings, all of the plants of some of the suseptible colored varieties were killed. The white varieties appear less attacked and Semple's white branching, while not entirely immune, is resistant. The pycnidia are found in the scurf covering the seed and the disease is spread in the seed bed. The lower leaves are first diseased but later the upper leaves and floral parts are attacked. The tawny colored spots may be isolated but, finally, unite and kill the entire leaf. The plant becomes dwarfed, the size of the flower reduced and the time of blooming is delayed. The pycnidia, 76 to 95 microns in diameter, are observed on either the lower or upper side of the leaf. The straight to flexuous, 3 septate, hyalin spores average 33.5 by 1.5 microns, although varying from 28 to 42 by 1 to 1.5 microns. Wild asters and golden rod, growing but a few feet from the asters, showed no Septoria and, that found

on the chrysantehmum showed pycnidia 190 microns in diameter with 7-septate spores 89 by 3.5 and varying from 54 to 114 by 3.3 to 5.5 microns. The exact control measures have not been fully worked out, although it appears to be amenable to treatment by seed disinfection and spraying with Bordeaux mixture.

The use of sterilized soils in phytopathological research. JAMES JOHNSON.

In experiments with pathogens of subterranean parts of plants the limitation of the soil organisms to definite or known forms is fundamental. Special difficulties may arise with sterilized soils where it is desired to prove the pathogenicity of weak parasites, or where certain physiological aspects of parasitism are to be studied. Toxic action either in the form of retarded growth or definite lesions frequently occur which may obscure the actual results. Beneficial action may in a similar way result in misinterpretations. Since individual soils vary widely in their behavior when sterilized by steam, and plant species react very differently to the effects of sterilization, it is important to consider these facts in using sterilized soil in experimental work. It is possible in most instances to avoid these complicating factors by selecting soils which are not toxic when heated, by using host plants which are not sensitive to the the toxic action, or by special treatment to reduce the injurious properties of the soil. Reinfested steam sterilized soils favor infection of host tissue due to the favorable medium offered by such soil for the reproduction of the parasite, but no evidence of modified susceptibility of host plants grown in sterilized soils has been found. As a result of the direct action of sterilized soil on the host plant various types of discolorations and lesions of roots and stems as well as "leaf spots" and "leaf blights" have been produced.

A constant humidity case. CHAS. F. HOTTES.

The apparatus to maintain a constant humidity within a variation $\pm$ 1%, consists of a plant chamber 20 $\times$ 20 $\times$ 20 inches constructed of wood with the top and sides of three thicknesses of glass to give two dead air spaces for insulation. This case is furnished with Johnson Service Co., humidostat and thermostat. The case sits on an accurately fitted base three inches in height, through which the supply pipes for the moist and dry air, respectively, pass into the case. The heating elements for the maintenance of a uniform temperature are attached to this base. Between this shallow base and another ten inches in height, is a perforated transite plate through which the shoots are passed into the plant chamber. The roots, in soil or in nutrient solution may be placed under conditions like or unlike those of the shoot, through independent regulation of the temperature, etc., of this lower base. The humidity is controlled by the humidostat making contact, now with one, then with the other terminal of an electro-magnetic valve (Johnson Service Co., old style) that will shift the flow of compressed air (20 lbs.) through the humidifying or the drying apparatus, respectively. The humidifier consists of a ten litre aspirator bottle furnished with an inlet tube tipped with De Vilbiss atomizer No. 28 and partly immersed in distilled water. The air from the valve, passing through the atomizer forms a fine spray and thus becomes rapidly charged with moisture, especially if the water is slightly heated. The air leaves the aspirator bottle through a condenser head and is delivered to the plant chamber by a connecting tube. The drying apparatus consists of a series of calcium chloride towers or a sulphuric acid atomizer (glass) for drying. The regulation is very simple and the range of the instrument is from 20 to 95% relative humidity. When adjusted for medium humidity and without plants in the chamber, the change from moist to dry air and the reverse occurs at intervals of about three minutes. With plants in the chamber the interval on the dry air is lengthened.

Bacterial leaf spot of lima bean. W. B. TISDALE and MAUDE MILLER WILLIAMSON.

A heretofore unreported bacterial disease of lima beans has been under observation since 1917 at Madison, Wis. Plants were severely affected during that season in some gardens, but such destructiveness has not been noted since. The disease appears early on the young plants, and observations indicate that the further spread may be checked by dry weather. Leaves, stems and pods are affected. The disease is most conspicuous on the leaves, where it is characterized as reddish-brown spots which later develop grayish centers. Often two or more spots coalesce to form irregular lesions several millimeters in diameter. It appears as reddish-brown streaks of varying lengths on the stems and petioles. On the pods brown spots are produced which extend through the wall and affect the seed coat. Slight water-soaking has been observed on the margins of some spots, and thin crusts of exudate have been noted under field conditions. The method of overwintering has not been determined, but since the seeds are invaded it is very probable that the organism is carried over with the seeds. A white, aerobic, non-gas-forming organism with polar flagella has been isolated from the diseased parts and the etiology determined. Literature contains numerous reports of different organisms attacking legumes, including lima beans, but descriptions indicate that they all differ from the organism under consideration.

Soybean bacterial blight. I. V. SHUNK and F. A. WOLF.

A comparison has been made of bacterial blight of soybean as described from Wisconsin (Jour. Agr. Res. 18: No. 4, 1919) and from North Carolina (Phytopath. 10: No. 3, 1920). The diseases differ somewhat in appearance but these differences are of minor importance and it is doubtful if one could differentiate them with certainty in the field. By the use of certain easily operable refinements which consist essentially in adjustment of initial reaction to neutrality and in reducing the hydrolyzation of sugars to negligible quantities, it is determined that the several strains of bacteria pathogenic to soybeans represent two distinct species, *Bact. glycineum* and *Bact. sojae*. They differ principally in that the former produces brown pigment with certain media and forms acid from dextrose, saccharose, lactose, maltose, and glycerine whereas the latter is non-pigment forming and forms acid from the first two of these sugars only. Both organisms have been isolated and proven to be pathogenic in Wisconsin and *Bact. sojae* alone has been found to be associated with soybean blight in North Carolina.

The relation of soil temperature and other factors to onion smut and infection. J. C. WALKER and L. R. JONES.

Onion smut offers an especially favorable subject for study of the relation of environment to disease since infection occurs only through the subterranean parts in the early seedling stage. Soil moisture variations inhibit infection only at the very high and very low extremes where germination and growth of the host is also retarded. Soil temperature relations as determined by the Wisconsin soil temperature tank method have marked influence. Onion seeds germinate and growth occurs at soil temperatures of 10° to 31° C. Best top growth occurs at soil temperatures of 20°. Seed smut infection occurs from 10° to 25° C; marked reduction at 27.5 C: complete inhibition at 29° C. Where infection has occurred there is a greater tendency for the seedlings to outgrow the disease at high air and soil temperature (25° C.) than at low temperatures (15° C.); however air temperatures as high as 30°–33° do not entirely prevent smut development provided the soil temperature is kept below 25° C. A series of out-of-doors plantings in inoculated soil, so timed as to expose successive crops of seedlings to gradually increasing temperatures showed that as the soil temperatures rose the

infection percentage fell, with complete inhibition when the mean reached 29° C. These facts have significance in relation to the geographical distribution of the disease. Smut occurs widely in the north where onions are planted in spring in cool soil and is not found in the South where late summer plantings are practiced in warm soils. Temperature records from northern and southern stations accord with the conclusion that soil temperature is a limiting factor.

A Macrosporium rot of onion. J. C. WALKER.

An undescribed bulb rot has been noted on white varieties of onions (large bulbs and bottom sets) in Wisconsin and Illinois for the past four seasons. Infection takes place usually at the necks of the topped bulbs, occasionally at other wounds. A semi-watery decay results in which the tissue usually becomes deep yellow to wine red in color due to the pigment produced by the causal fungus. The older decayed tissue eventually becomes dark brown to black due to the development of dark-colored mycelium. Usually one to three outer scales are affected, which in the case of bottom sets results in total loss of infected bulbs. Repeated isolations from diseased bulbs consistently yielded a species of Macrosporium which on potato dextrose agar ordinarily produced an abundance of yellow to red pigment which diffuses throughout the substratum. Sporulation is very sparse in culture but can be induced by wounding the mycelium as described by Kunkel and by Rands for *Macrosporium solani*. The disease was readily produced by inoculation of healthy bulbs.

The occurrence of dodder on onions. J. C. WALKER.

Three instances of dodder (*Cuscuta* sp.) attacking the tops of onions have been noted: (1) at Stockton, Calif., in 1919, (2) at Racine, Wis., in 1920, and (3) at Lansing, Ill., in 1920. The first two instances were on the large bulb crop and little damage was done. In the last, however, the parasite has caused considerable damage to onion sets. In a field of ¼ to ½ acre examined shortly before harvest, thirteen oblong patches were found varying in size from 4 × 6 to 15 × 21 feet. In the centers of the largest patches the tops of the plants had been completely killed and the bulbs were much reduced in size. The dodder appeared in one or two centers when the onions were about two inches high. From these it had been spread by weeders and cultivating implements to other parts of the field. Unless care is taken by onion set growers to eradicate this parasite early in the season, it may prove to be a serious pest, especially under the prevailing methods of culture in which the plants are grown under extremely crowded conditions and continuous cropping is commonly practiced.

Seed transmission and overwintering of cabbage black rot. JOHN MONTEITH, JR.

Frequent observations in Wisconsin have shown black rot to be more severe in fields from imported than from home grown seed. Experiments showing definitely the method of overwintering and the relation of climatic factors to the early development of the disease are lacking. An attempt is being made to clear up these points. The disease persists in overwintered seed heads. However, our experience with one such plant showed that it failed to mature seed but might serve as a center of infection. The organism probably lodges on the seed coats during threshing and is carried over to the next season in this manner or possibly within the seed from systemic or pod infection. Clean seed, sown in sterilized soil mixed with diseased cabbage leaves which had been exposed to a Wisconsin winter, yielded seedlings with a high percentage of infection. Artificially inoculated seeds, allowed to dry three days and planted in

sterilized soil, yielded seedlings with a large percentage of cotyledon infection. Subsequent progress under greenhouse conditions was slow, however, the disease seldom appearing on the first true leaves in less than eight weeks after planting. Evidence points to climatic factors during seed bed growth as important in determining the rapidity of spread in the seed bed from primary centers and consequently the severity of epiphytotics.

Greenhouse propagation of cabbage resistant to yellows. J. C. GILMAN and A. T. ERWIN

A method for developing strains of cabbage resistant to yellows in the greenhouse has been devised for use in the case of early cabbage which cannot be stored satisfactorily. The seed was planted in flats of soil infested with *Fusarium conglutinans* and subjected to the optimum temperature for the development of the disease. The selections were made about a month later, the healthy seedlings being transferred to pots and later to a garden bed in the greenhouse. The plants came into flower late in March and produced abundant seed. This method has been used successfully for three years. Seed from these plants showed resistance in the field in both 1919 and 1920. The relative resistance from the plants selected was as follows:

	1919		1920	
	NO. PLANTS	PER CENT YELLOWS	NO. PLANTS	PER CENT YELLOWS
Best strain	73	23.3	27	0
Average of selected strains	540	25.5	2531	22.0
Commercial seed	646	61.3	897	63.7

The merits of these resistant strains as to type and earliness have to be determined in the field.

Bremia on hothouse lettuce. I. E. MELHUS.

Under Iowa conditions *Bremia lactucae* has caused serious losses to the greenhouse lettuce crop. It is most rampant on plants in the seedling stage. This organism like some species of Cystopus and Phytophthora flourishes only at low temperatures and in an atmosphere of very high humidity. The optimum temperature for its spore germination is from 6 to 10° C. a temperature which prevails in the lettuce houses during the winter and spring months. The wild species of Lactuca: *L. scariola* var. *integrata*, *L. canadensis*, *L. sagittifolia* and *L. ludoviciana* are common as foul weeds about compost piles, vacant lots and fence corners. All of the above species are readily infected with *Bremia lactucae* occurring on cultivated lettuce and vica versa. The downy mildrew probably spreads from the wild to the cultivated lettuce. In this latitude the wild species of Lactuca are winter annuals and may serve as means for carrying the organism over from one season to the next in the vegetative stage. Although very frequent search has been made for oospores in cultivated lettuce plants, none have been found. Bremia is able to survive in hot house soil from one year to another, providing it is not allowed to freeze. The control of this disease has been effected by spraying the lettuce seedlings with Bordeaux mixture (4–4–50) two or three times before they are transplanted.

Celery yellows. G. H. COONS and RAY NELSON.

The stunting disease of celery first discovered at Kalamazoo, Mich., in 1914, as a serious disease of the Golden Self Blanching variety has increased in extent so that

practically all soil in the immediate vicinity of that city is no longer capable of producing this particular variety. The disease is also known from all other extensive celery districts in the state. It is also a serious disease in New Jersey, Indiana, Massachusetts and Connecticut. Although first suspected as being of bacterial origin, and reported by other observers as due to the joint action of bacteria and Fusarium, definite proof is now available for assigning to a new species of Fusarium the causal relationship of this disease for which the name Celery Yellows is proposed. The variety Easy Bleaching and all of the so-called green varieties are tolerant to this disease. In the golden varieties excessive stunting occurs, accompanied by yellowing and thickening of the foliage, together with reddening of the vascular system.

Recent studies on bacteriosis of celery. R. F. POOLE.

Celery rots, due to a bacterium, have been severe for a number of years in New Jersey. Greatest losses occurring where Golden Self Blanching varieties are grown on muck soils. The green varieties, previously considered as being immune to the bacterium, were found to be slightly susceptible to the organism. When Golden Self Blanching varieties are planted in muck soils not later than May 15th a good crop is usually produced; temperature at this time not being favorable for the development of the organism. "Heart rot," "foot rot," "leaf blight," and "browning of young roots" are the principal symptoms of decay. Repeated isolations and inoculation experiments have proven that all these are due to the same organism. With the exception of a few minor cultural growths, this soft rot Bacillus conforms to the descriptions of *Bacillus carotovorus* (Jones) and of *Bacillus apivorus* (Wormald). These are probably different strains of the same organisms. Inoculations made with this organism in a partly saturated atmosphere and at temperatures ranging from twenty-five to thirty-five degrees Centigrade have produced soft rots on the green varieties of celery in twenty-four hours. Plants inoculated under normal conditions and allowed to dry rapidly gave negative results.

Bacterial spot of tomato. MAX W. GARDNER and JAMES B. KENDRICK.

Bacterial spot is a typical spot disease of the fruit, leaves and stems of tomatoes in Indiana and nearby states. Raised, black, scab-like lesions with watersoaked borders are produced on the fruit. The centers of these lesions may later become sunken. Because of the fruit spots this disease is extremely objectionable to market gardeners and canners. Leaf lesions are black and greasy with parchment-like centers which tend to crack. The causal organism is being described as a new species of bacteria. It is highly sensitive to acidity in culture. Leaf infection is stomatal, while fruit infection has been secured only through wounds such as needle punctures. Ripe fruits are immune probably because of their high H-ion concentration. Forty-one varieties of tomatoes have been found susceptible and no resistant varieties have been found. The causal bacteria have survived eight months desiccation on tomato seed. Inoculated seed has yielded diseased seedlings with characteristic primary cotyledon lesions and commercial seed saved from fruit grown in a badly infested field yielded about 1% of infected seedlings when planted in sterilized soil. The organism is carried over winter on the seed. Seed disinfection in mercuric chloride, 1:3000, for five minutes has been found safe and effective and is recommended as a control measure.

A phytopthora crown rot of rhubarb. W. S. BEACH.

An investigation of a crown rot of rhubarb prevalent in Philadelphia County, Pa., has revealed in the discolored tissues of the buds, the petiole bases, and the roots the

constant presence of a gnarled, coenocytic mycelium that is chiefly intracellular. The culture of this mycelium proved it to be that of an undescribed species of Phytophthora. Conidia and oospores are abundantly produced on lima bean agar, but these structures have not been observed on host material from the field. In preliminary inoculation experiments pure cultures of the fungus were pathogenic on vigorous petioles of large rhubarb plants and on seedlings of moderate size. Diseased tissues turn dark brown, but may not soften or break down.

The disease becomes severe during wet weather in late summer, and has caused the sudden death of considerable areas in rhubarb fields, usually in those recently set, having poor drainage, or receiving heavy manuring. Colletotrichum on the petioles is much more severe on plants affected with crown rot. Numerous other fungi found to be saprophytic complete the decay of the dying or weakened plants, but with the return of dry weather many plants recover in part.

Studies in parasitism in the Fusarium group. H. C. YOUNG and C. W. BENNETT.

Experiments with *Fusarium oxysporium* have confirmed the view that wilting of potato plants when attacked by this fungus is not due to a mechanical plugging of vascular tubes, but is due to certain products of the fungus acting on the host tissue. Wilting can be produced by a water solution of alcoholic precipitate derived from 28 day cultures in Richard's solution. The exact nature and chemical composition of the substance or substances responsible for wilting are being investigated.

The pathogenicity of Corticium vagum as affected by soil temperature. B. L. RICHARDS.

Studies conducted during the seasons 1918–1919 in Wisconsin, both in the field and under controlled conditions in the greenhouse, have shown that the temperature of the soil is a vital factor in determining the degree to which the potato and other crops may be damaged by *Corticium vagum* B. & C. (*Rhizoctonia solani* Kühn). The fungus may produce lesions on the underground stems of the potato plant in soils ranging in temperature from 9° to 29° C. Severe damage to this plant, however, is limited to soil temperatures below 24° C. with an optimum for tissue destruction between 15° and 21° C. Destruction of the growing points of the young shoots does not occur at soil temperatures above 21° C. This feature of the disease is clearly correlated with the rate of growth of the primordia. Experiments with the potato, the pea, and the bean indicate that the temperature requirements for the pathogenic action of the fungus on these hosts is determined by a fixed physiological character of the fungus, and is but slightly influenced by the temperature relations of the hosts, or by the species of plants on which the parasitic relation becomes established. No definite correlation was found to exist between the optimum temperature for the growth of the fungus in artificial culture and that found most favorable for its maximum parasitic action.

Tip-burn and the leafhopper. G. P. BURNS.

The remarkable paper recently reported which tended to show that tip-burn in the potato was due to the leafhopper because plants protected by a wire cage with meshes sma l enough to exclude the beetle were not affected, caused the writer to investigate the effect of such screens upon other factors of the habitat, such as solar radiation, wind velocity, humidity of the air, evaporation etc. and also on the rate of transpiration of coniferous and broad-leaved plants. The results show that in addition to excluding the beetle the wire cage exerted a profound effect upon all the factors of the habitat and greatly decreased the amount of water transpired. Some of these results were as follows:

	OPEN FIELD	UNDER WIRE SCREEN
Solar radiation	100%	49.9%
Wind velocity	100%	7.8%
Evaporation		
White atometer	100%	60.0%
White lack atomemeter	100%	54.8%
Light Intensity		
Clements Photo	100%	43.0%
Humidity	100%	105.0%
Temperature	100%	106.0%
Transpiration		
White pine	100%	66.6%
Norway spruce	100%	84.2%
Hydrangea	100%	73.0%

These results would seem to indicate that we should use the greatest caution in assigning causes of physiological phenomena.

Second report on the reaction of American potato varieties to the wart disease. FREEMAN WEISS and C. R. ORTON.

Test of American potato varieties for reaction to the potato wart disease begun in 1919 were continued during 1920 at Freeland, Pa., and at Thomas, W. Va. Forty-three varieties, in addition to those tested last year, were grown this year, of which 17 appear to be immune. Twenty-one selected seedlings developed by the U. S. Department of Agriculture were tested and 5 proved to be immune. To date, 78 named varieties of American origin have been tested. Of these, 27 are immune. Of 51 seedlings from the Department of Agriculture 12 are immune. The designation immune is used advisedly, as these varieties do not become infected at all, even when grown in soil in which non-immune varieties are readily and severely attacked. The 17 varieties and seedlings reported as immune in 1919 have fully justified this title in the 1920 tests both in the Pennsylvania and West Virginia tests. Similarly, foreign immune varieties remain entirely free from infection when in this country. The list of American immune varieties now includes Irish Cobbler, Flourball, First Early, Early Eureka, Early Petoskey and New Early Standard of the Cobbler group; Ehnola, Extra Early Sunlight, White Albino and Early Harvest of the Early Michigan group; Spaulding Rose, Northern King and White Rose of the Rose group; Burbank, of the Burbank group; Green Mountain, Green Mountain Junior, McKinley, New Oregon, McGregor, Norcross and Gold Coin of the Green Mountain group; Round Pink Eye and McCormick of the Peachblow group; and Keeper, Success and Ursus, which are unclassified.

Catalase, hydrogen-ion concentration and growth in the potato wart disease. FREEMAN WEISS and R. B. HARVEY.

A study was made of H + concentration and catalase activity in the overgrowths of the tubers of Irish potatoes caused by infection by *Chrysophlyctis endobiotica*. The H + concentration of wart tissue is constantly greater than that of healthy tubers from the same plant, the values being represented by pH6.00 and pH6.49 respectively. Catalase activity is much greater in the wart tissue, the values being represented by 17.9 for diseased and 7.8 for the healthy tissue. Catalase activity is strongly correlated with growth in spite of the higher acidity of the proliferation. This differs from other types of plant overgrowths previously studied in which diminished acidity is correlated with increased catalase and growth activity.

The present status of the potato wart in Pennsylvania. W. A. McCUBBIN.

Surveys for wart in 1920 and previous years by federal and state agencies, together with additional scouting planned for 1921, will practically complete the preliminary efforts to locate the disease in all suspicious areas. In any permanent policy for locating further outbreaks, scouting must be supplemented by publicity methods to arouse widespread public interest. Potato wart has now been found in 53 towns and villages in 9 counties in Pennsylvania. 781 gardens are known to be infested in these places. The actual area of these gardens is less than 100 acres, though the infection centers are scattered about in two general districts which together involve some 3000 square miles of territory.

The Pennsylvania state quarantine aims to prevent all movement of infectious material, particularly potatoes and manure, from the areas under quarantine, and to replace, as rapidly as possible, susceptible potato stocks with immune varieties, not only in the quarantine area itself, but in a "safety zone" about it. Seed of immune varieties is grown under supervision and then tagged and distributed under seal.

In the quarantine area potatoes can be grown only under permit, which plan facilitates the detection in summer of all plants of susceptible varieties accidentally or unintentionally introduced.

Inoculated vs. uninoculated sulfur for the control of common scab of potatoes. WILLIAM H. MARTIN

The work with sulfur for the control of scab has been continued this year, the scope of the work being broadened to include tests of inoculated and uninoculated sulfur. Inoculation was effected by mixing the commercial sulfur flour with one per cent of soil from a compost heap known to be well supplied with sulfofying organisms.

Soil samples were taken before the sulfur applications were made and again at digging time. The hydrogen-ion concentration of water extracts of the soil samples was determined colorimetrically. The inoculated sulfur brought about greater decreases in exponent values than the uninoculated sulfur and with each decrease below that of the check plots there was a corresponding decrease in the per cent, of scabby tubers. While only a few experiments were conducted with the inoculated sulfur its advantages over the uninoculated were rather definitely established.

Inoculated sulphur for potato scab control. R. E. VAUGHAN.

The use of inoculated sulphur, "Bac-sul" for the control of potato scab in Wisconsin, 1920, was not successful. Bac-sul was applied at the rate of 400 pounds to the acre when the plants were breaking ground. In one experiment, 35 per cent showed scab where treatment was used, with 37 per cent scab in the check. In another experiment on heavier soil, the scab in the treated lot was slightly over half and in the check rows slightly less than half. The slight variations in the amount of scab could easily be accounted for by the natural variation in amount of soil infection. The season was very dry from the time the sulphur was applied until harvest.

Testing seed potatoes for mosaic and leaf-roll. F. M. BLODGETT and KARL FERNOW

Attempts were made to eliminate potato mosaic and leaf-roll from small lots of seed for seed plots (1) by growing one tuber from each hill as an index to the entire hill, and (2) by growing one eye from each tuber as an index to the remainder of the tuber. In several lots of hill units, only single stalk hills were selected as it was thought that these might behave more uniformly as to disease than hills with a number of stalks. This did not appear to be the case. In the limited number of tests made, there was

nearly as large a percentage of mixed hill units, part mosaic and part healthy, in the progeny of single stalked hills as in hills with a number of stalks. Only small decreases in the percentage of mosaic were obtained by sorting out the hills labelled mosaic on the basis of the greenhouse test of one tuber from each hill. Considerable reduction in the percentage of mosaic was secured, however, by sorting on the basis of an eye test of individual tubers. By this method in two tests a reduction from a percentage of about 27 to 1 was secured and in a third test from 65 to 33.

Cooperative seed treatment using hot formaldehyde. R. H. PORTER

This method has been successful under Iowa conditions in treating a large quantity of potatoes in a short time and is suited to community cooperative effort. Creameries or steam engines are practicable as a source of heat. Farmers organize their own seed treatment centers. In one case over 530 bushels were treated in less than six hours.

Treated and untreated seed planted in the same field have shown a decided advantage in favor of the treated seed. In four fields which were planted with treated seed in 1919, and averaging about 8 acres in size, 15 per cent of the tubers were infected with scab. The untreated seed in each case was planted in the same field but usually consisted of 4 to 10 rows. These plots showed 76 per cent scab.

In 1920 four fields planted with treated seed and averaging about 5 acres showed 33 per cent of the tubers infected with scab as compared with 68 per cent in the four plots planted with untreated seed. The basis of percentage determination used was the number of infected tubers out of the total yield of equal areas. A single scab sorus was sufficient to place a tuber in the infected class.

The control of Rhizoctonia was as follows: Four plots in 1920 planted with treated seed gave an average by weight of 11.1 per cent infection as compared to 35.4 per cent in the plots planted with untreated seed.

Cooperative potato seed treatment experiments. (Committee Report). I. E. MELHUS

Cooperative potato seed treatment experiments for the control of *Rhizoctonia solani*, were carried out by the Iowa, Wisconsin and Minnesota Experiment Stations in 1919 and the Iowa and Wisconsin Stations in 1920. Solution of formaldehyde (1–240) cold for two hours, formaldehyde (1–120) 50°C for 2 minutes, copper sulphate (3–4000) for 2 hours, and mercuric chloride (1–1000) for one and one-half hours were tes‘ed comparatively. Seed was treated in the various ways by each station and then divided so that each station had plots of the various treatments of their own and the other two station's seed.

The Minnesota seed at Minnesota showed that copper sulphate gave less control than hot formaldehyde, but the reverse was true of these same treatments under Iowa conditions. The mercuric chloride gave better control of the disease than the copper sulphate, but not as good as the hot formaldehyde at Minnesota but was poorer than either at Iowa. At Wisconsin the mercuric chloride and the hot formaldehyde were about equally efficient, the copper sulphate giving the poorest results. Double strength formaldehyde at 8°C for 2 hours gave fair control at all three stations.

The Wisconsin seed was planted at but two stations, Iowa and Wisconsin. At Wisconsin mercuric chloride for 1½ and 2 hours gave the best control, while formaldehyde gave practically none, At Iowa the hot formaldehyde equalled the mercuric chloride for 1 hour. Although it was not as good as the 1½ and 2 hour treatment with the solution.

The Iowa seed at Minnesota showed good control of the disease with both the hot formaldehyde and the mercuric chloride, although the former was slightly better here and also at Iowa. The reverse was true at Wisconsin.

In 1920 Iowa and Wisconsin alone cooperated. Wisconsin seed at Wisconsin showed excellent control with mercuric chloride and practically none with formaldehyde hot or cold. At Iowa cold formaldehyde showed the best results, hot formaldehyde the second and mercuric chloride third. Copper sulphate was ineffective at either station.

Iowa seed at Wisconsin showed best control with mercuric chloride, second with cold formaldehyde and poorest with hot formaldehyde. At Iowa hot formaldehyde was best. Again copper sulphate was ineffective.

The cooperative potato spraying project. (Committee Report). G. R. BISBY.

During 1918, 1919, and 1920, the need for further knowledge regarding the effect of field applications of Bordeaux mixture to potatoes in certain regions of North America was brought to the attention of workers in the various states and in Canada. The preliminary questionaire in 1918 resulted in a general response giving the status of the problem in various states, and some new data. A definite project was drawn up for 1919, and submitted to workers who might be interested. The problem was again brought before many pathologists in 1920 with the suggestion that the cooperation of entomologists would be valuable.

Cooperators have been able to add much to the knowledge for certain regions regarding the value of spraying and the schedule advisable, etc. There are still, however, large areas in North America where information is lacking, or results are uncertain. The results obtained, the methods employed, and the future possibilities of this project should be discussed.